

# Speech and Voice Impairments in Individuals with PD

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# Parkinson's Disease

- Progressive disorder which affects about 1 million people in the U.S.
  - About 60,000 new cases are diagnosed per year
- One of the most common neurodegenerative diseases
- Has far reaching effects on the brain, resulting in motor, speech, language, and cognitive impairments

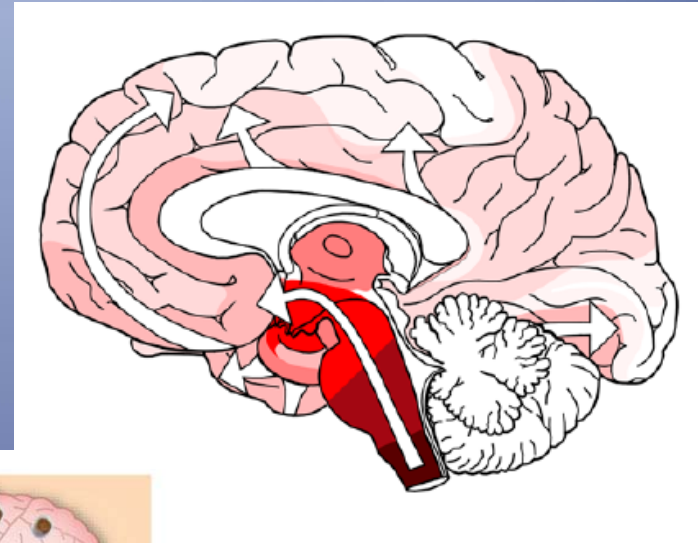
# Causes of Parkinson's Disease

Aggregation of  $\alpha$ -synuclein and mitochondrial damage are potential causes of neuronal death in PD, including dopamine producing cells

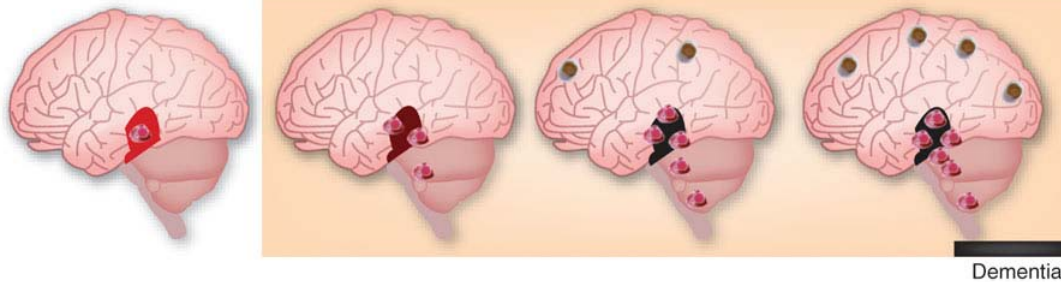


Images taken from: [niehs.nih.gov](http://niehs.nih.gov); [larasfriends.com](http://larasfriends.com)

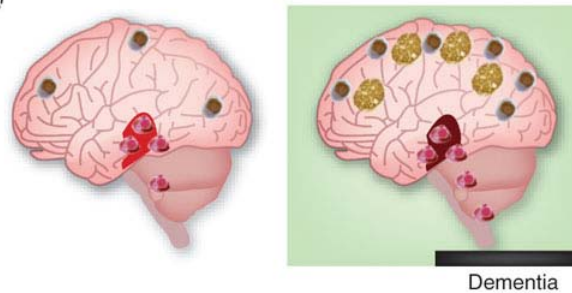
# Causes of Parkinson's Disease



Parkinson's disease



Parkinson's disease with dementia (PDD)

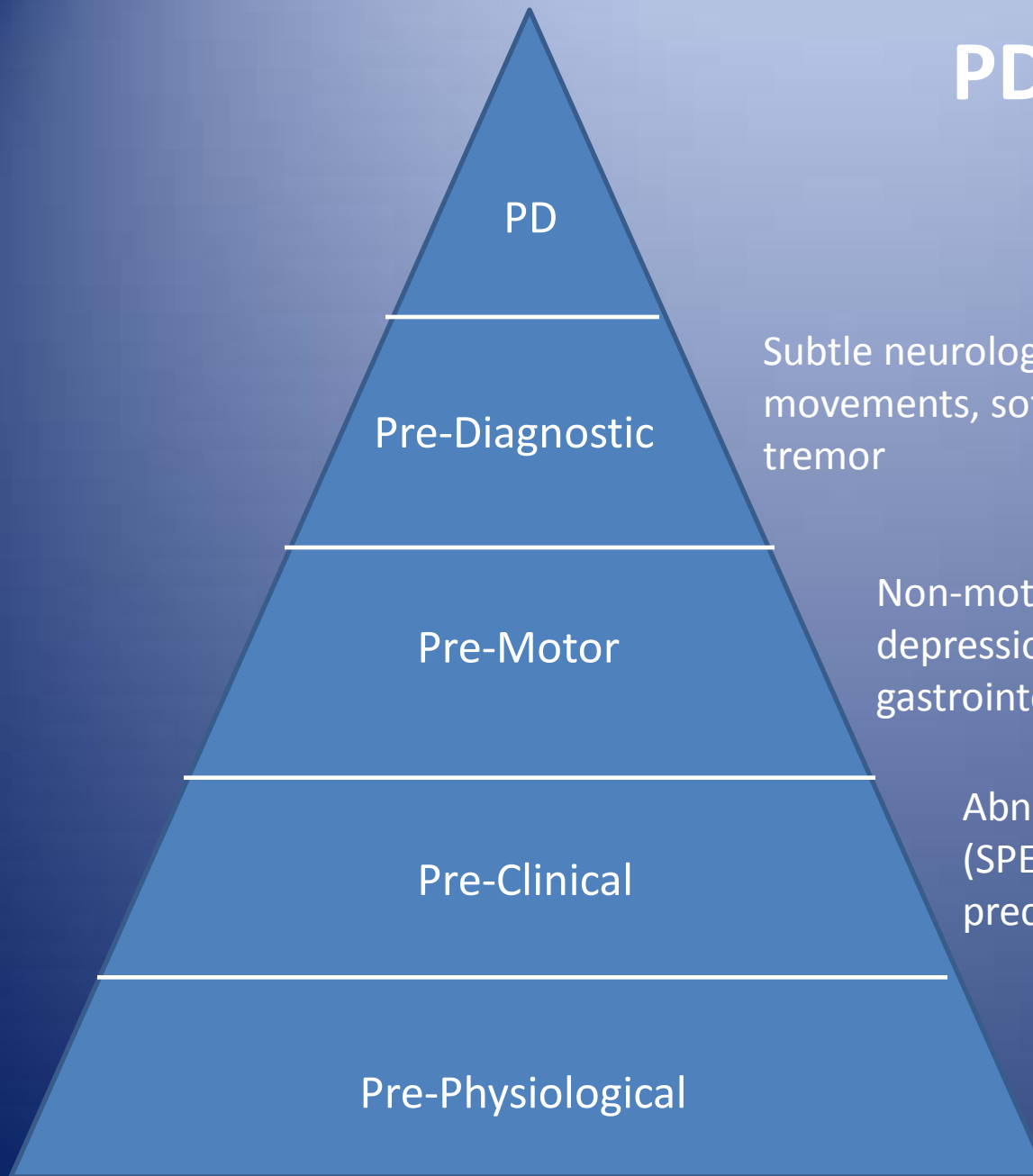


Preclinical

Age (years) 55 60 65 70 75 80

Images taken from: Braak et al. (2004); Obeso et al. (2010)

# PD progression



PD

Pre-Diagnostic

Pre-Motor

Pre-Clinical

Pre-Physiological

Subtle neurological features: small, slow movements, soft, monotone voice, tremor

Non-motor features: olfactory loss, depression, cardiac, visual, gastrointestinal function, REM disorder

Abnormalities on imaging markers (SPECT); imaging abnormalities precede neural symptoms

Genetic mutations  
high risk for PD; no motor or non-motor features of PD

Adapted from the Parkinson's Associated Risk Syndrome (PARS) Study





Stern MB, Siderowf A., 2010; Stephenson, R., 2008,

Slide courtesy of Cynthia Fox

# Common Speech Impairments

- Alterations to muscle tone and control affect the muscles which underlie speech
  - 89% will develop voice problems
  - 45% will develop articulation problems
- Perceptual features:
  - Reduced loudness (hypophonia)
  - Breathiness
  - Monotone (reduced pitch and loudness variation)
  - Disordered rate and short rushes of speech

# Examples of Speech Impairments

- Mild female: hoarse voice quality, monotone 
- Mild male: breathy voice quality, some disfluencies, slightly fast rate 
- Severe female: hoarse voice quality, fast rate, hypophonia, monotone, slurred articulation 
  - Talking about making a turkey
- Severe male: breathy voice quality, fast rate, hypophonia, monotone, slurred articulation 
  - Talking about rehab hospitals he has been in and therapy he has received

# Does this speech problem matter?

“if I have no voice, I have no life” - Natalie

“No one listens to me anymore” - Shirley

“... my struggle with my voice has been the most  
challenging, caused me more heartache and frustrations.”

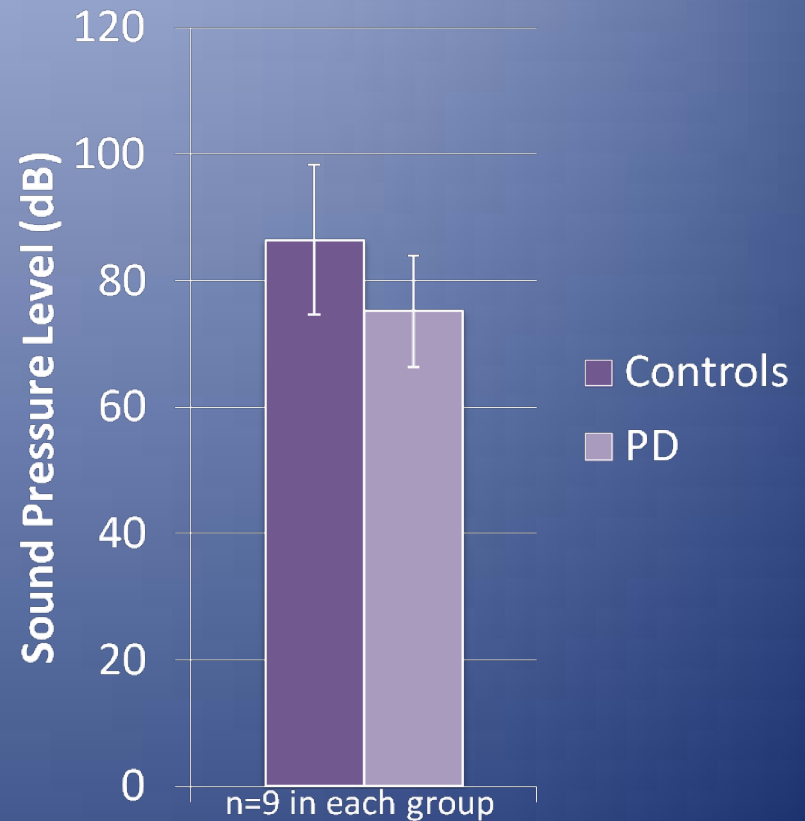
- Mike

“People talk over me as if I am not talking” - Mary



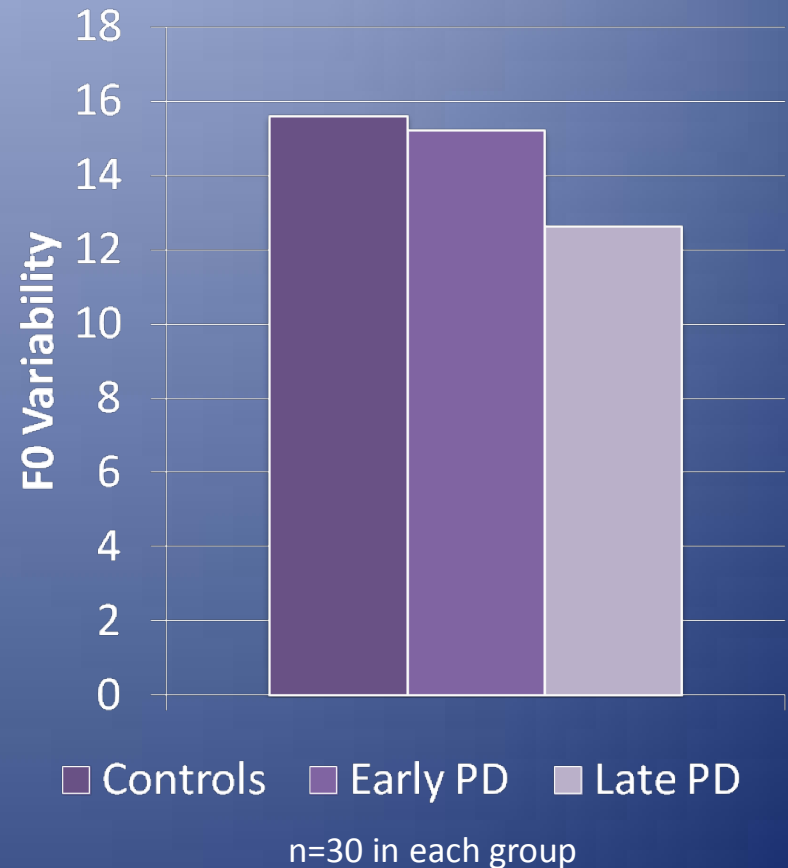
# Hypophonia

- Sound pressure level (SPL) is the physical correlate of loudness
- Some individuals with PD have a lower SPL
- **Impact:** Communication partners are hearing impaired, exponentially increasing the effect on communication



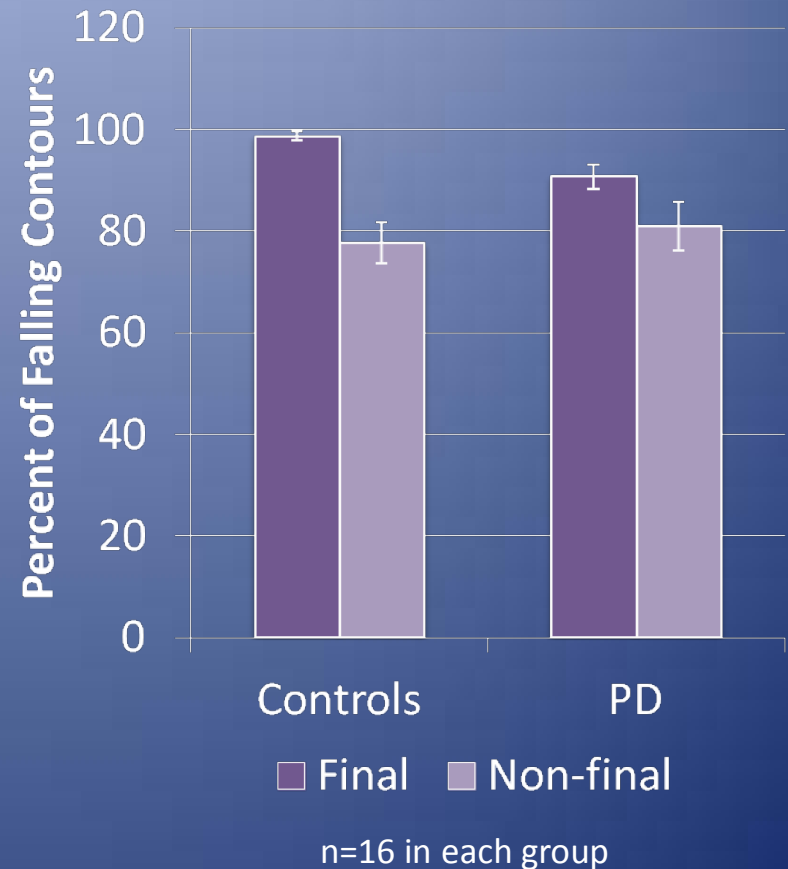
# Monotone Voice

- Fundamental frequency (F0): physical correlate of pitch
- Reduced F0 range and variability
- Reduced marking of stressed words or focus of sentences



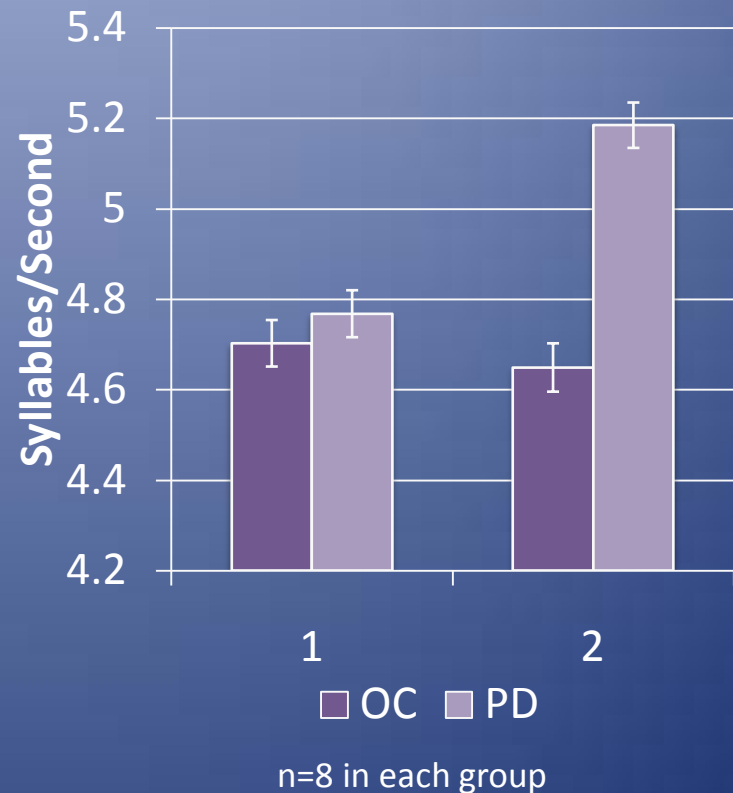
# Monotone Voice

- Reduced distinction between questions and statements
- Reduced marking of final and non-final clause boundaries
- **Impact:** Reduces listeners ability to parse incoming speech signal



# Changes to Speech Rate with Disease Progression

- Shorter utterances
- Faster speech rate
- **Impact:** Harder for listeners to distinguish sounds and words, less time to comprehend incoming speech



Data from Huber and Darling (in prep)

# PD: Self-Perception

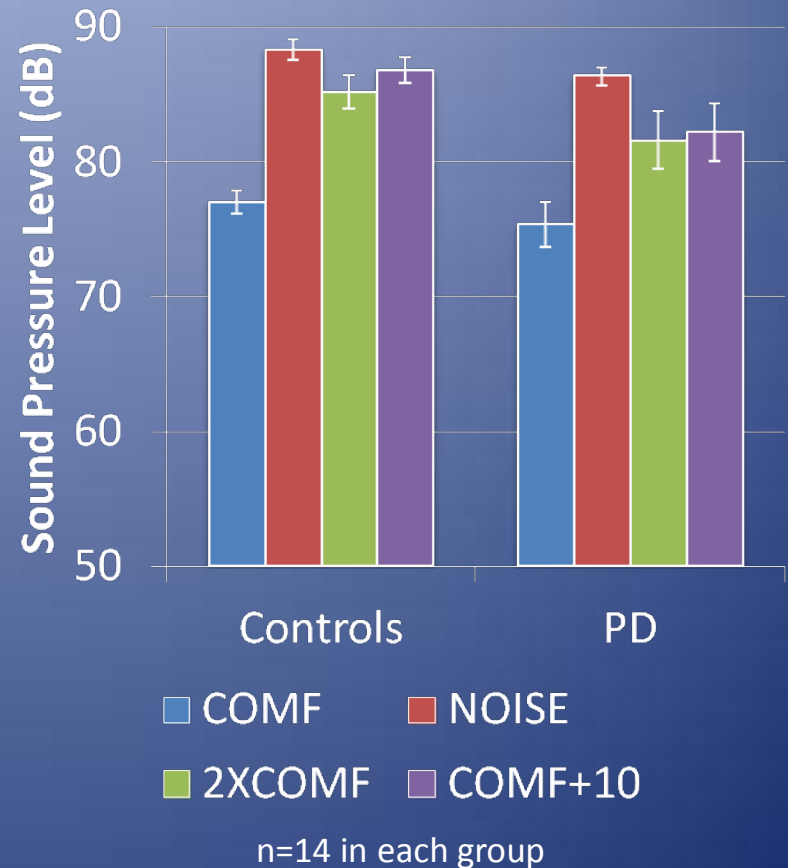
- May not perceive their speech and voice problems as severely as their communication partners
- Individuals with PD have difficulty accurately perceiving their own loudness
- Do not perceive speech errors as accurately as control subjects
- **Impact:** Therapy is difficult because we need to teach them that their speech is impaired

# Cueing

- External cues: visual or auditory feedback to perform a task
- Internal cues: unconscious information or self-cueing guides task performance
- Improvements in gait patterns have been shown in response to both external and internal cues
  - Internal cues did not generalize as well as external ones
- Similar findings for handwriting and speech as in gait

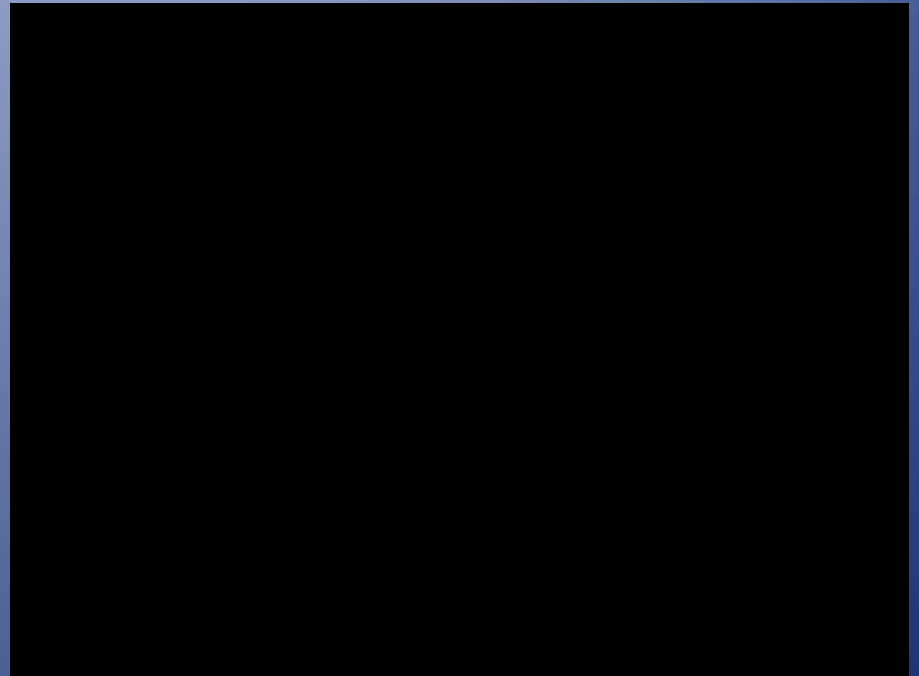
# Cueing

- Some cues work better than other cues for achieving a specific goal
- Most speech therapy for people with PD aims to improve loudness or rate
- **Impact:** The cues used in therapy will affect the outcome



# Example Effect of SpeechVive™

- SpeechVive™ is a voice-activated device which uses a natural external cue, noise (Lombard effect), to elicit and louder, clearer speech
- Patient with Parkinson's disease
  - Comfortable and then with the SpeechVive™
  - Is currently on medication for PD and uses a deep-brain stimulator





# Causes of Speech Impairments

- Do not know the underlying cause or neurophysiology for changes to speech
- Do not know which patients are more likely to develop speech impairments

# Causes of Speech Impairments

- Speech impairments are not remediated by the treatments which improve limb motor symptoms
  - L-dopa therapy does not improve speech
  - DBS often causes a worsening of speech and cognition symptoms
- The causes of speech impairments are likely to be distinct from those of limb motor symptoms
  - The effectiveness of behavioral therapies for speech improvements informs us regarding underlying causes
  - Need animal models to begin to elucidate the causes of speech changes and to determine which patients are at greatest risk

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