

# VOT voicing contrast is robust along a speech rate continuum in dysarthria

## Background

### Research Questions

What happens to the VOT voicing contrast in hypokinetic dysarthria along a speech rate continuum from **very slow** to **very fast**?

Compared to controls, how do people with PD differ in ...

**RQ 1:** Habitual rates of speech and adjustments in speech rate?

**RQ 2:** VOT voicing contrast in slow speech?

**RQ 3:** VOT voicing contrast in fast speech?

Parkinson's disease is associated with a reduced VOT voicing contrast (Whitfield et al., 2017)

Other speech symptoms of **hypokinetic dysarthria** (present in up to 90% of people with PD; Logemann et al. 1978) include:

- Imprecise articulation
- Abnormal rates: slower, faster, festinating
- Reduced variation in pitch, loudness
- Soft, quiet voice (Darley, Aronson, & Brown 1969)



Speech rate modification as **treatment** and window into **speech motor control**

- **Speaking more slowly:** behavioral intervention that sometimes (but not always) leads to improvements in speech intelligibility and acoustic distinctiveness in dysarthria (Yorkston et al., 2007).
- **Speaking more quickly:** Associated with collapsed contrasts in healthy talkers (Byrd & Tan, 1996). Not typically a treatment target.
- **VOT & speech rate in healthy talkers:** In healthy talkers, asymmetrical changes in voiced/voiceless VOT, potentially leading to increased voicing contrasts in slow speech, and reduced voicing contrast in fast speech (Miller et al., 1986; Kessinger & Blumstein, 1998).

## Methods

### Participants

**Healthy Older Controls** (n = 17)

**Parkinson's disease** (n = 34; 12 with deep brain stimulation)

### Speech task

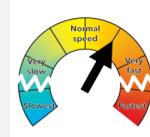
24 nonce words  
 C: /p, t, k, b, d, g/ V: /i, u, æ, a/

"Please say aCvD again"

### Rate modification

#### Blocked magnitude production:

7 rate conditions (habitual, 3 fast, 3 slow) elicited via magnitude production to elicit broad continuum of actual speech rate. Based on actual rate, binned into:



#### 5 proportional speech rate categories.

"Please speak at a rate that feels 2x/3x/4x faster/slower"

### Analysis

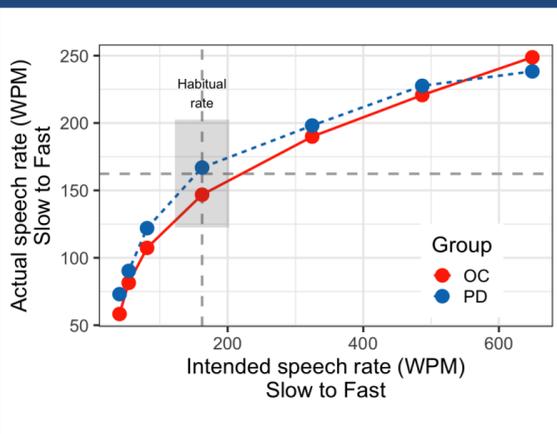
$$\text{Log}(VOT) \sim \text{Group} * \text{Rate} * \text{Voicing} + \dots + (\dots / \text{Participant}) + (1 / \text{Item})$$

- Modified rates compared to habitual (treatment contrasts)
- Additional variables & 2-way interactions were iteratively added as appropriate and kept if model fit improved (e.g., place of articulation).
- Random by-participant slopes for rate

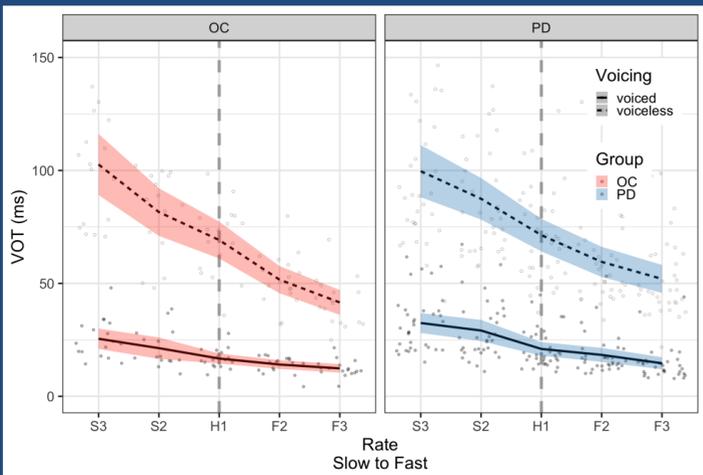
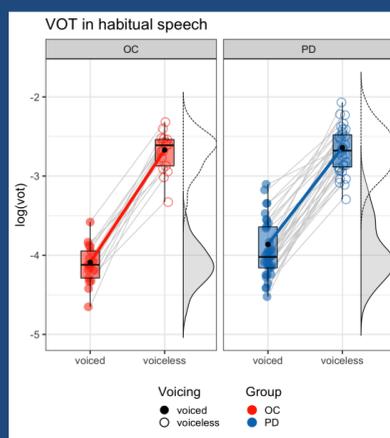
## Results & Discussion

### Q1: Habitual rate & rate adjustments

Compared to older healthy controls (OC), talkers with PD showed...



- **Faster habitual rate** of speech but...
- **Similar proportional rate adjustments**
- Small reduction in VOT contrast due to **longer voiced VOT**



Compared to OCs, talkers with PD showed...

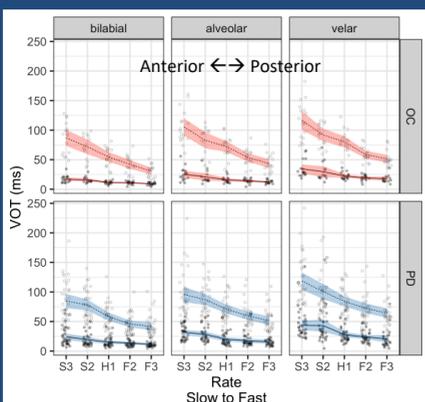
### Q2: Slow speech

- LESS contrast at the slowest rate (S3)
- **Voiced VOT** → greater increase

### Q3: Fast speech

- MORE contrast at all faster rates (F2, F3)
- **Voiceless VOT** → less decrease

➔ **Voicing contrast is robust to rate in Parkinson's disease**



**Velars:**  
 less contrast for both groups  
 More anterior place  
 ↓  
 More "fanning out" of contrasts

### Implications

- Slow speech not as effective in increasing voicing contrast in PD as in healthy talkers
  - Negative implications for speech intelligibility in slow speech?
- Voicing contrast maintained in faster speech for PD, not for OC:
  - Compensatory or constraint?
- Deficits in coordinating laryngeal & supralaryngeal systems → implications for sensorimotor integration?

## Selected References

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