Phonetics and phonology of special populations

DISCUSSANT:

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What are "special populations"?

"Special Populations" comprise people who show some deviation from healthy, typically developing/developed performance patterns.

Classification:

	Developmental	**Acquired**
Stable	Cerebral Palsy Hearing Loss Intellectual Impairment Autism	Traumatic Brain Injury Stroke Hearing Loss
Progressive	Muscular Dystrophy	Multiple Sclerosis Parkinson's Disease Hereditary Ataxia

Problems experienced by these populations

- Impaired auditory perceptual ability => **speech perception**
- Reduced motor control / Hypo- vs Hyperarticulation / Over- vs Undershoot => **speech production**
- Reduced cognitive skills => **language production**

Relationship between research into fundamental and clinical aspects of speech

- Studies of healthy populations (developmental and adult speaker data) provide important norms to compare pathological populations against
- New methodologies from phonetics/phonology can be translated into valuable clinical diagnostic and therapeutic tools
- Observations of pathological processes can inform models of normal speech/language production and perception, underlying neurophysiology

1. Healthy norms

- Most investigations into pathological speech focus on your children or the elderly
- => require information on:
  - Normal development
  - Healthy ageing
  - Normal speaker variation - need more meta-analyses

Normal development

Lots of areas where norms are still needed, particularly for

- Unscripted speech/language performance
- Prosody

2. Diagnostic & Therapeutic Developments

- Norms important for diagnostic assessments to define "normal"
- Methods developed for healthy speakers / cross-linguistic investigations also fundamental for clinical work
- Can provide evidence for appropriate choice of task design, measurement parameters and elicitation method

2a. Task Design:
Multi-Word Intelligibility Test (MWIT, Kent et al. 1989)

- Diagnostic assessment not only used to identify presence of a problem, but also pinpoint nature of impairment to inform effective treatment
- Intelligibility tests usually only provide a severity indication, e.g. how many words / what proportion of sentences is understood?
- MWIT deviates from that and provides specific information on the phonetic contrasts that are impaired in pathological speakers

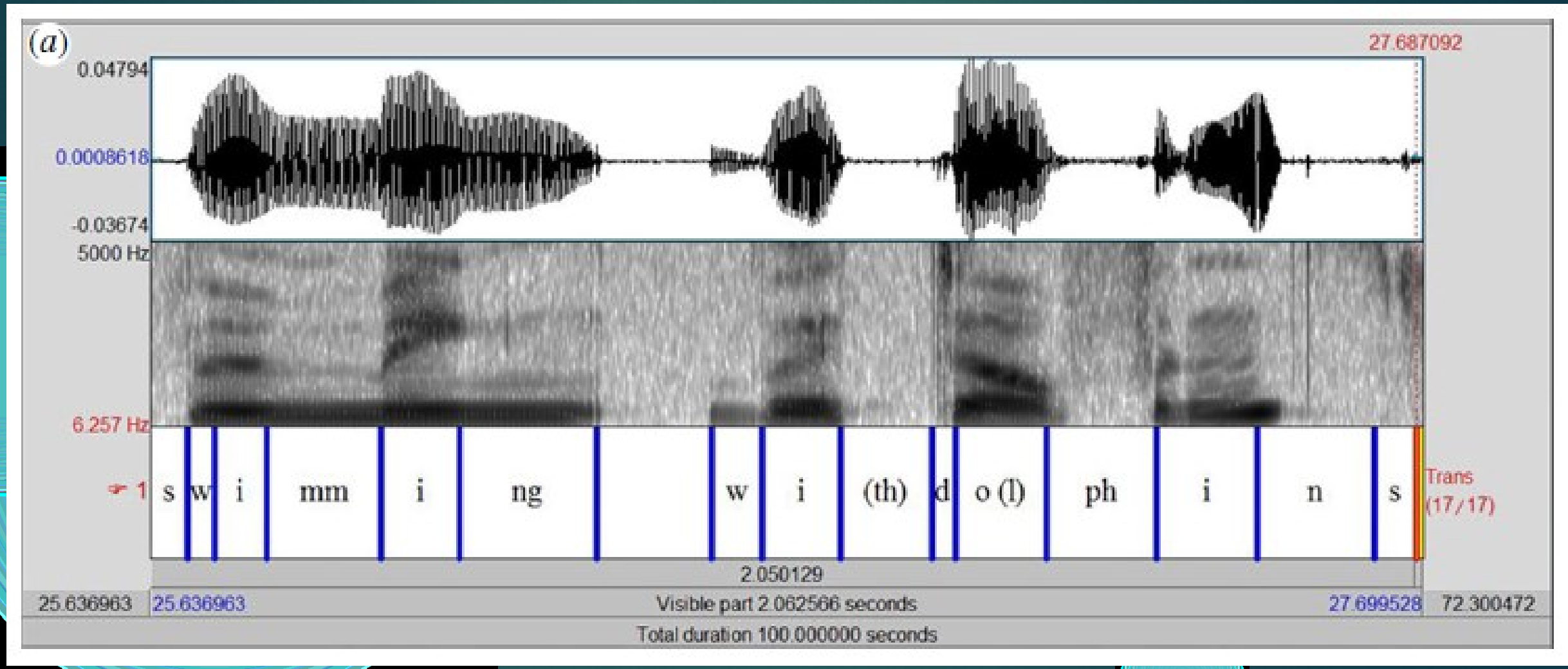
MWIT (Kent et al. 1989)

Target	Listener choice
bad	**bad – pad – bat – ban**

- => MWIT systematically investigates problems with voicing, place and manner to inform therapy goals
- Test has been translated into other languages, e.g. – different phonetic contrasts / minimal pairs
- Needs to be perceptually validated to ensure that contrasts are phonologically important in a particular language
- Increasingly diverse bilingual population requires fundamental research into phonological structure of different languages to allow construction of language appropriate assessments

2b. Measurement Parameters:
Rhythm Metrics

- PVI (Low et al. 2000), VarcoV (White & Mattys 2007), %V (Ramus et al. 1999), etc.
- Developed to capture perceptually defined rhythm categories (syllable vs stress timed)
- Adopted for disordered speech to highlight rhythmic disturbances
- Initial papers investigated which metrics were best suited to capturing rhythmic impairment in pathological populations (e.g. Henrich et al. 2006, Liss et al. 2009)
- Has subsequently led to realisation of rhythmic involvement in a wider range of patient groups than previously thought
- & more detailed information on the articulatory breakdown in pathological speakers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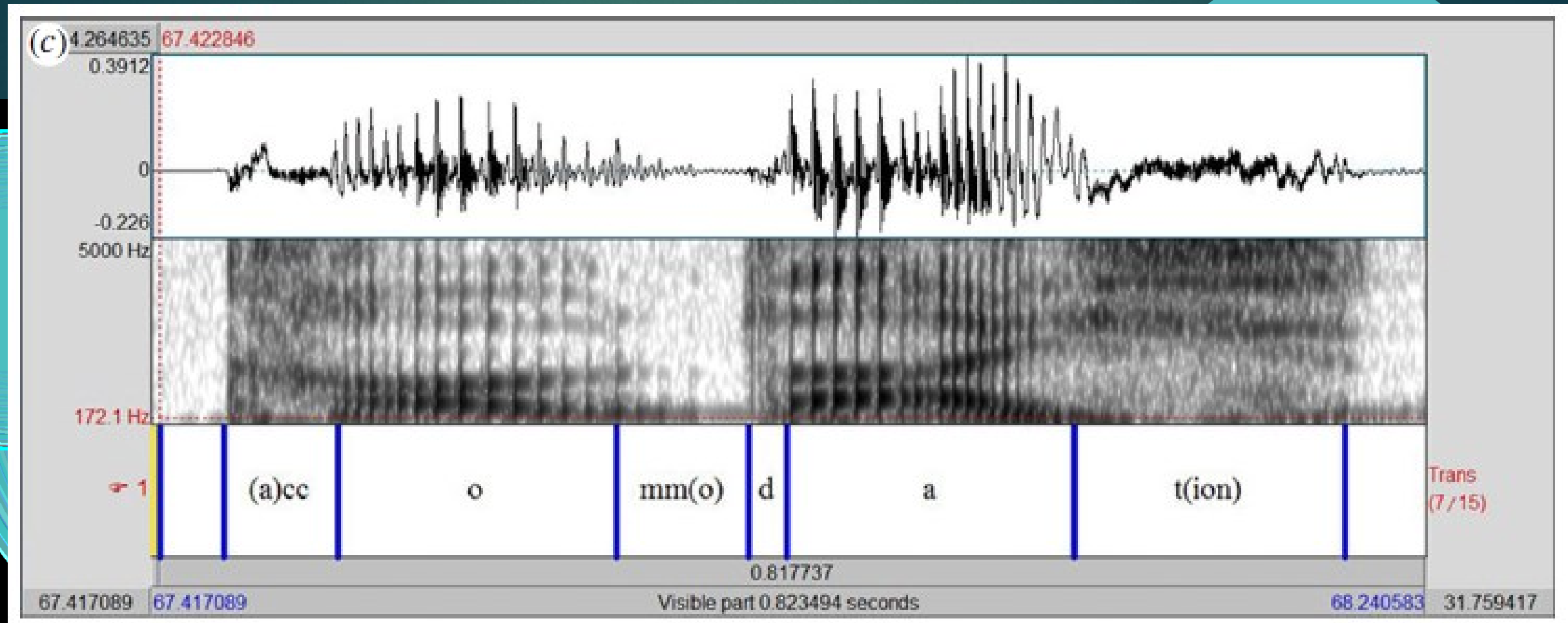
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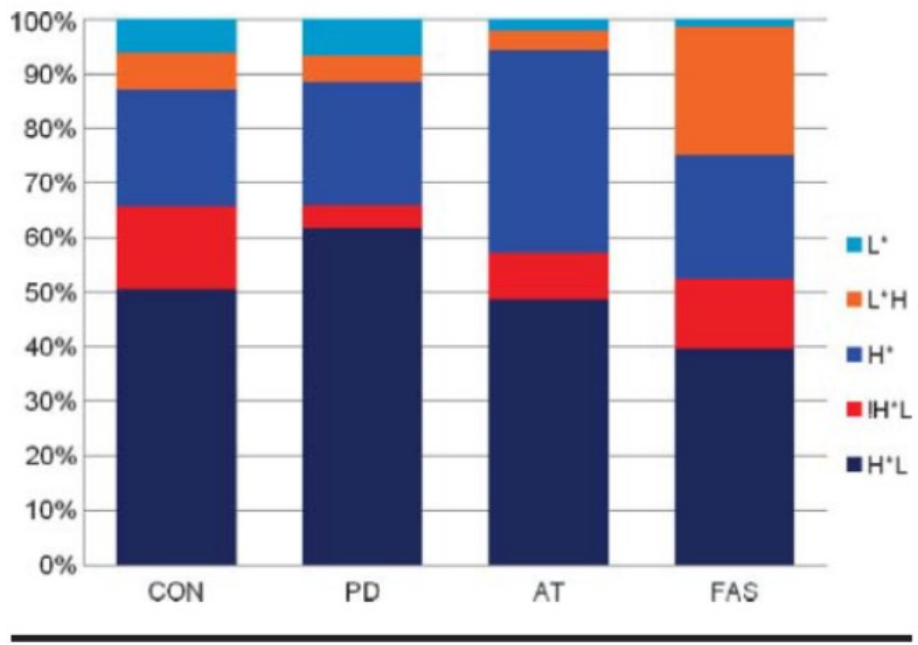
Intonation

- Using the AM approach provides greater insights into pitch performance of disordered populations

- Cavazzini et al.
- Ma et al. (2010)
- Lowit & Kuschmann (2012)

Figure 2. Pitch-accent inventory per speaker group in percent, that is, number of total occurrences in percent. CON = control speakers; PD = Parkinson's disease; AT = ataxic dysarthria; FAS = foreign accent syndrome; L = low; H = high.



2c. Elicitation Methods

- Evidence of significant task specific performance variations in clinical populations
- Cavazzini et al study is an excellent example of a tightly controlled study into speech problems and differences between healthy and pathological speakers
- At the other end we have Abbeduto's argument that naturalistic, unscripted speech will best reflect everyday behaviour & impairment, and possibly be more sensitive to differences and change over time
- Need to be sure that task & measurement parameters are sufficiently reliable to identify speech problems amidst natural performance variations created by less structured speech samples

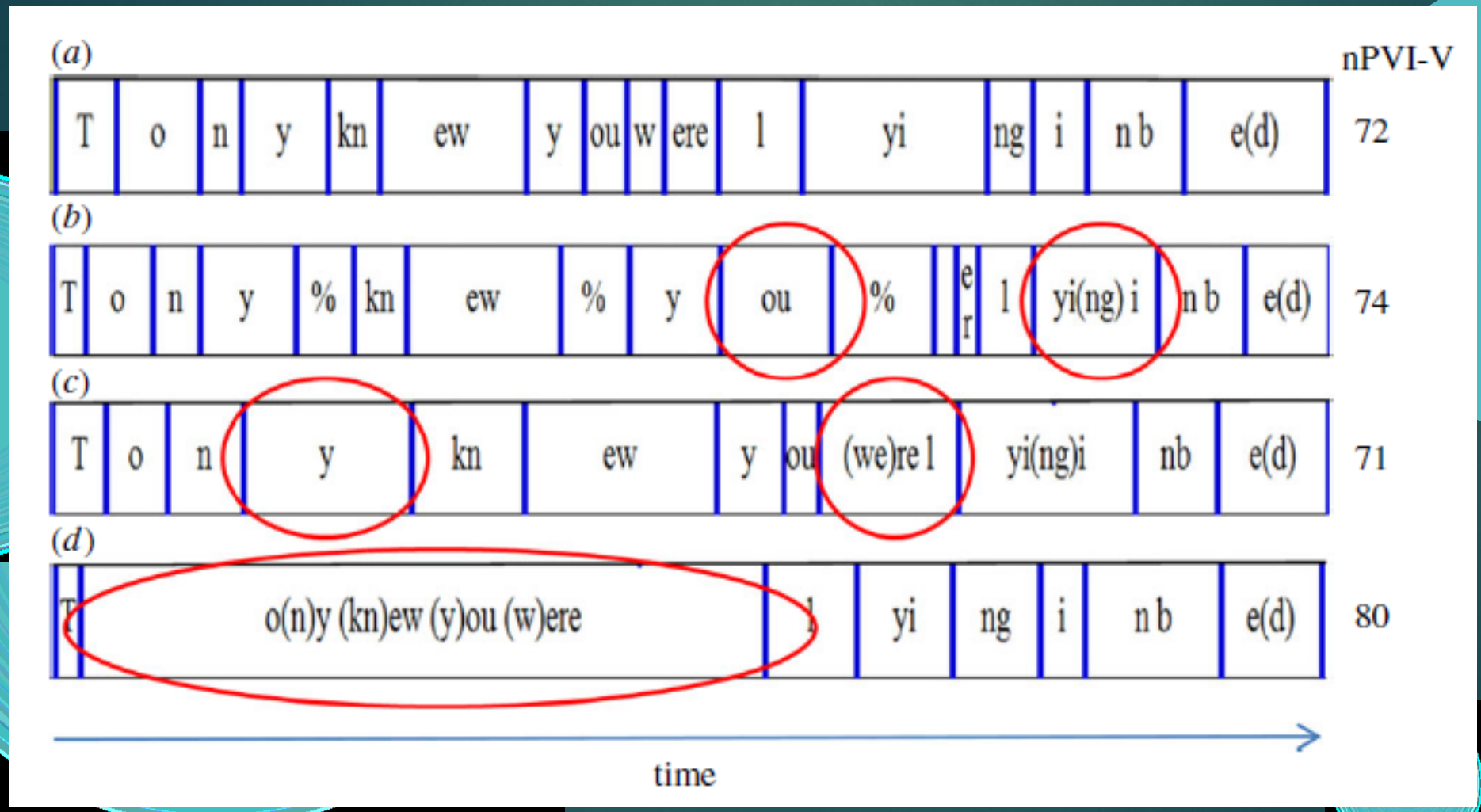
Lowit et al. (2018) *Rhythmic performance in hypokinetic dysarthria: Relationship between reading, spontaneous speech and diadochokinetic tasks*. Journal of Communication Disorders, 72, 26-39

- Based on Tilsen & Arvaniti's(2013) report that rhythmic differences between languages could be captured by read as well as spontaneous speech samples
- Results showed that not only could conversational data be used to highlight rhythmic problems in speakers with Parkinson's Disease
- This speech sample was in fact more sensitive to speech problems in this mildly impaired speaker group than reading data
- Information can feed back into fundamental research as evidence for validity of unscripted data as the basis for investigations

3. Better understanding of normal speech processes

- Pathological speech provides a window into underlying neurophysiology, speech motor control and phonological processes, as well as the interface between speech and other related ares
- Cavazzini et al. study shows clearly what happens to speech output during activation/de-activation of certain brain regions
- Dachkovsky & Sandler: unique opportunity for hypothesis testing (grammaticalisation) & tracking over time
- Chang et al. provided more information on the processing of diverse information listeners use in speech recognition

Acoustic – Perceptual Mismatch for Rhythm:



Lowit (2014) Phil Trans B

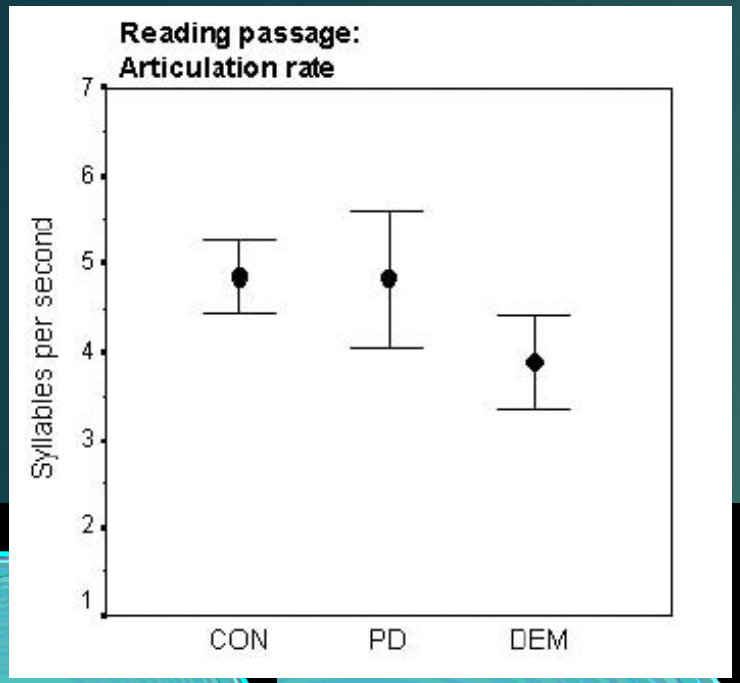
- Phrase final lengthening can impact on rhythm metrics – cf Arvaniti (2009) for Korean English
- Some speakers had normal durational relationships but perceptually disordered rhythm => rhythm is more than speech timing
- Lowit et al. (2014) demonstrated relationship between rhythmic impairment and intonation
- Arvaniti (2012) had also argued for reconsideration of Dauer's (1987) call to consider the role of stress in the characterisation of rhythm

Interface between phonetics, phonology, language and cognition

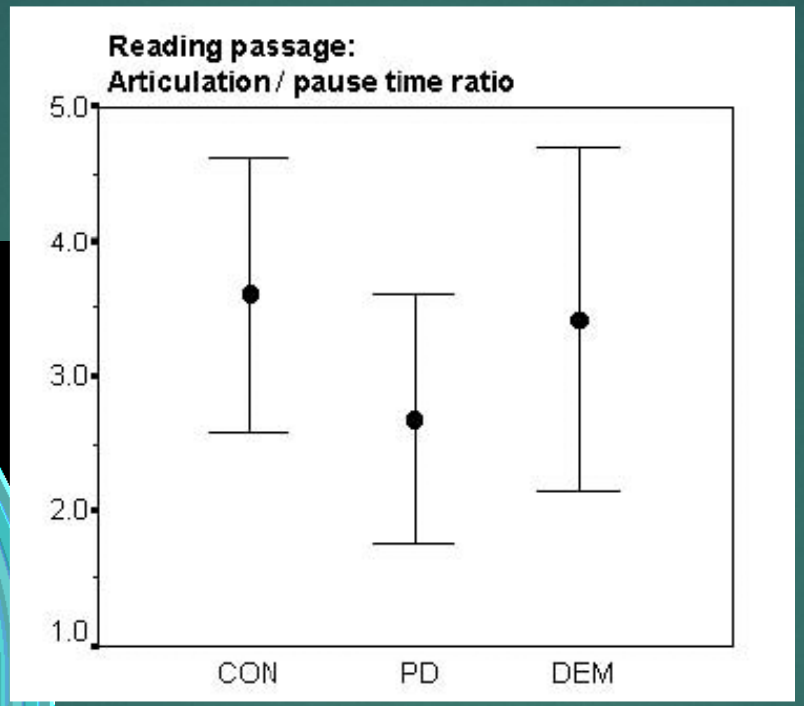
- Speech – language interface increasingly used for automatic detection of degenerative disorders such as Alzheimer's Disease & PD.
- Tend to focus mainly on pausing behaviour
- To what degree is increased pausing due to speech limitations (reduced breath support), language difficulties (utterance planning, word retrieval), or other cognitive issues (attention, memory, etc.)
- Pathological populations are ideal to study this aspect, as they tend to have multiple areas affected
- => can study the impact of specific impairments on other dimensions

Lowit, Brendel, Dobinson & Howell (2006) *An investigation into the influences of age, pathology and cognition on speech production.* Journal of Medical Speech Language Pathology, 14: 253–262

- Comparison of speakers with Parkinson's Disease (no cognitive decline), mild dementia and healthy controls
- Passage Reading
- Sentence Reading at habitual, fast and slow rates

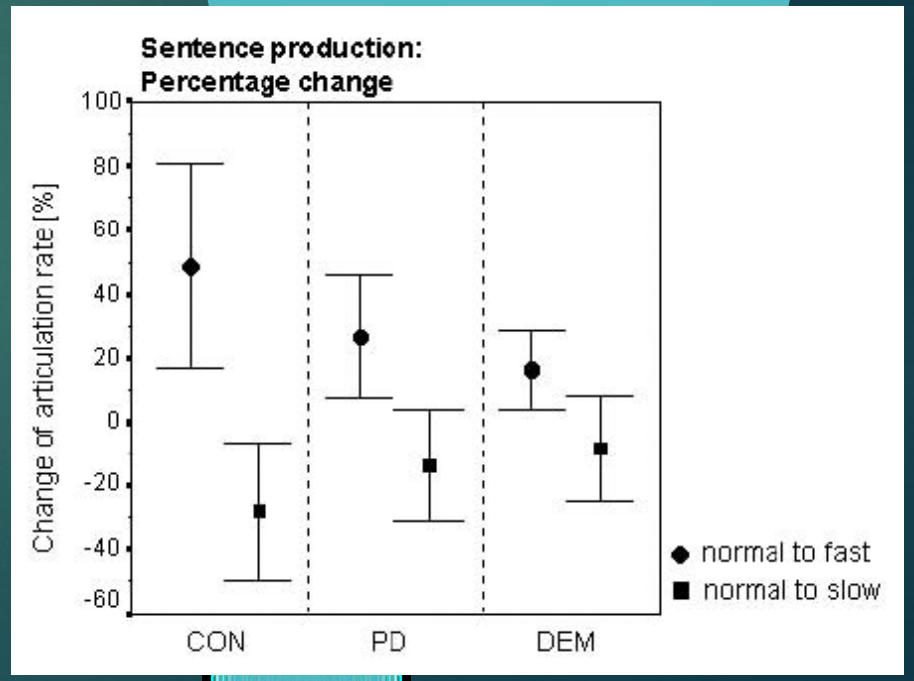


DEM slower than CON & PD = ageing factor?



PD produced more/longer pauses than CN & DEM = physiological restrictions?

DEM least able to change rate.
More cognitively impaired PD perform more like DEM than CON



Lowit & Kuschmann (2012)

Table 2. Overview of the phrasing and accentuation measures, mean intonation phrase (IP) length (in syllables) and pitch accent (PA)–syllable ratio (average distance between PA in syllables) and the phonetic measures, maximum phonation duration (MPD; in seconds), speech rate (in syllables per second), and F0 variability (coefficient of variation) per speaker group.

	CON		PD		AT		FAS	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
IP length	6.96	0.87	5.51	1.08	4.24	0.92	5.63	0.93
Syllable–PA ratio	3.82	0.36	3.42	0.38	2.52	0.31	3.54	0.24
MPD	18.44	10.59	13.40	4.92	8.83	4.99	9.50	3.65
Speech rate	3.54	0.52	3.21	0.92	2.18	0.45	2.50	0.50
CV F0	0.21	0.05	0.19	0.06	0.25	0.09	0.18	0.04

Note. CV F0 = coefficient of variation; CON = control speakers; PD = Parkinson's disease.

PD: shorter IP length than CON, but no significant reduction in breath support

Lowit et al. (2018) & Thies et al. (2018)
Relationship between speech, cognition and language in PD

- Study of 22 people with PD & healthy controls
- speech (non-speech, reading & focus task),
- language (grammar task, sentence generation, picture description)
- & cognitive tasks (cognitive screen, verbal fluency, attention, memory)
- =>
- Some aspects of speech and language are impaired independently of cognitive performance
- In cases of significant correlations both speech and language relate to performance in the Trail Making Test

Conclusion

- There is a close relationship between fundamental and clinical research
- Information flowing both ways
- Closer cooperation between the two areas has potential to drive research forward in a way that isolated approaches are unable to achieve