Investigating morphological processing using the MALD database: A megastudy of auditory lexical decision

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Morphological Processing: November 4, 2019

APhL
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My start in morphology…

Bretschger, O., M. Lisi, C. F. McGinley, and B.V. Tucker. (1995). *Elevation distribution, diameter, morphology of small volcanic edifices on Venus between Guinevere Plantia and Sedna Plantia*. Presented at Twenty-sixth Lunar and Planetary Science Conference (Houston, TX).

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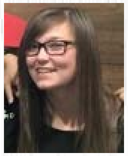
Collaborators and Acknowledgements

Daniel Brenner

Catherine Ford



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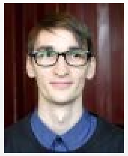

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This research was in part funded by the University of Alberta, Kule Institute for Advanced Studies, and the Social Sciences and Humanities Research Council.

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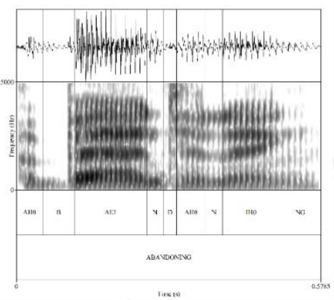
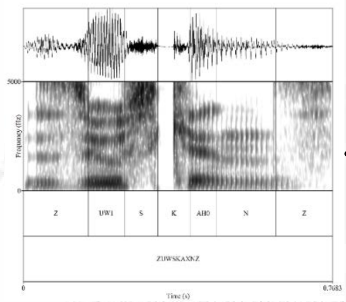
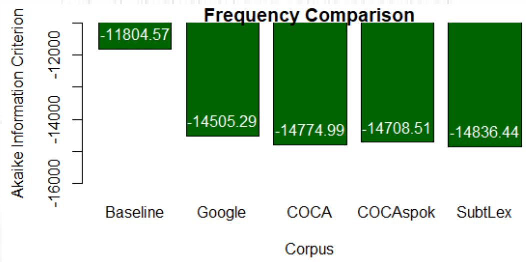
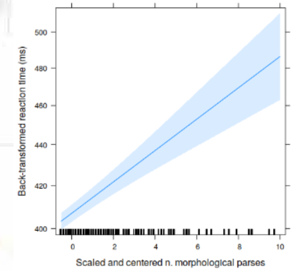
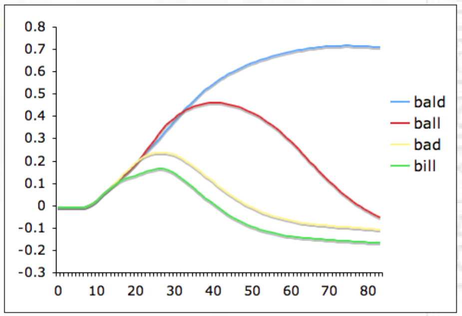
Massive Auditory Lexical Decision

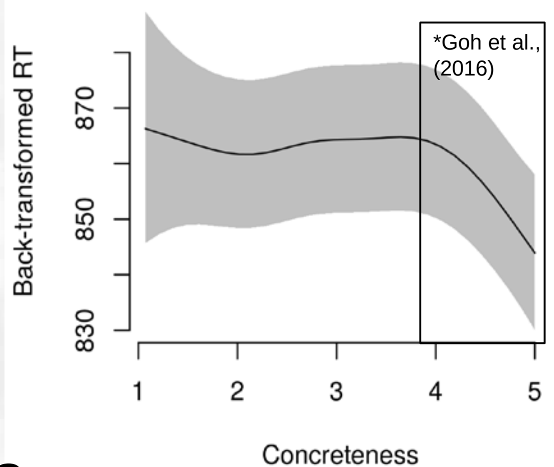


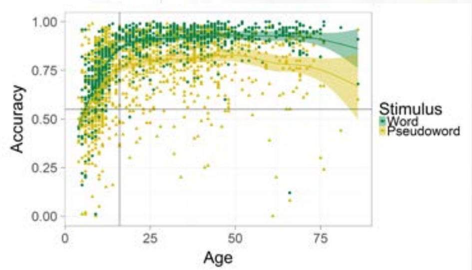












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‘Megastudies’ have several important advantages:

- statistical power
- minimization of strategic effects
- comprehensiveness
- multi-functionality
- complementing traditional small factorial experiments
- model development and testing

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Megastudies: the “visual” Lexicon Projects

- English Lexicon Project (Balota et al., 2007): 40,000 words and pseudowords
- French Lexicon Project (Ferrand et al., 2010): 38,000 words and pseudowords
- Dutch Lexicon Project (Keuleers et al., 2010): 14,000 words and pseudowords
- British Eng. Lexicon Project (Keuleers et al., 2012): 28,700 words and pseudowords

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Megastudies: Auditory projects

- Biggest Auditory Lexical Decision Experiment Yet or BALDEY (Ernestus Cutler, 2015):
  - 5,541 words and 5,541 pseudowords
  - 10 female and 10 male listeners
- MEGALEX both visual and auditory recognition of French (Ferrand et al., 2017)
  - 28,466 visual words and pseudowords
  - 17,876 auditory words and pseudowords

    used speech synthesis to create all of their stimuli

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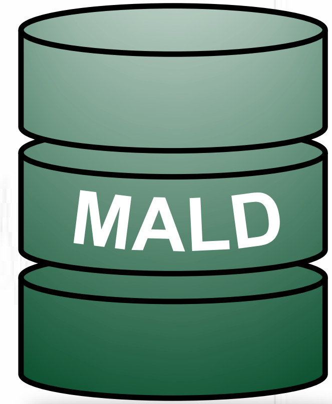
Massive Auditory Lexical Decision: Our Megastudy



- Male Western Canadian English speaker (age 32) recorded in a sound attenuated booth
- About 2,000 words/day or 800 pseudowords/day
  – 26,800 English words
  – 9,600 pseudo-words
- All items provided with segmental level mark-up (p2fa, Yuan & Liberman, 2008)

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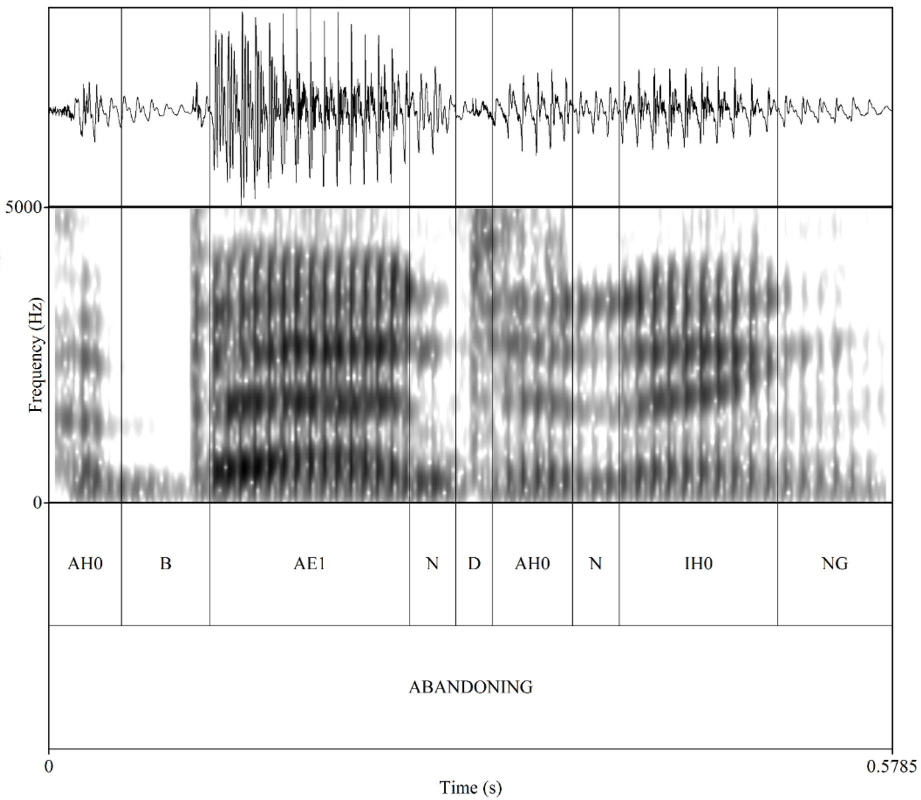
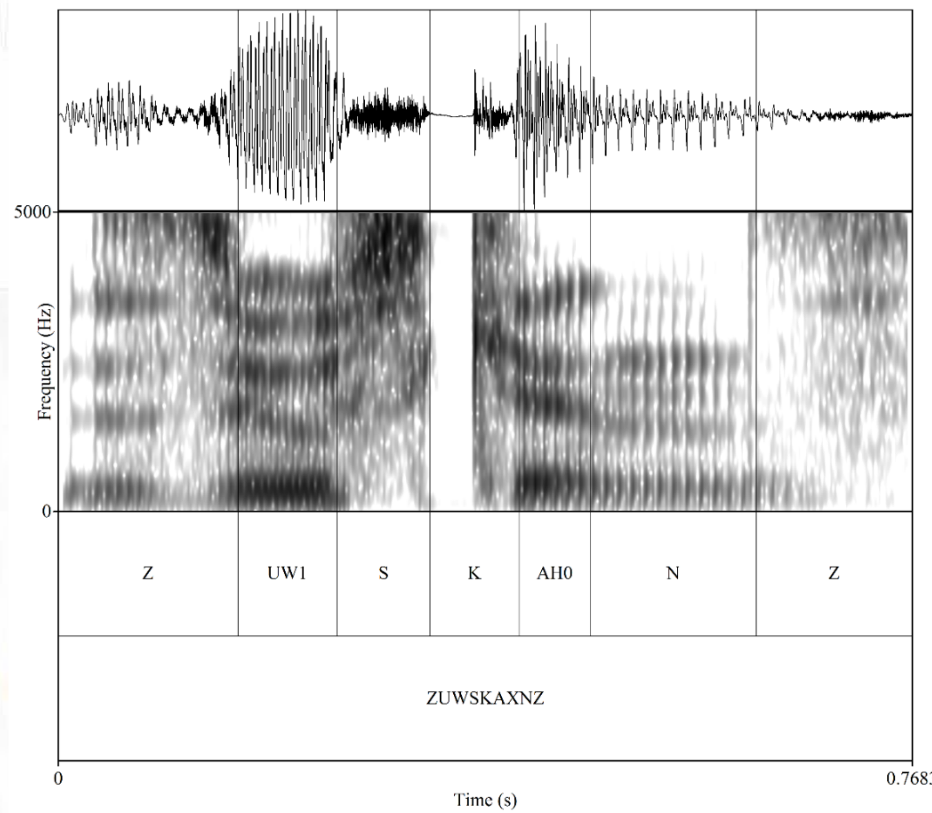
What do the stimuli look/sound like?





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Procedure: Massive Auditory Lexical Decision

- Hearing screening
- Auditory Lexical Decision task
- Session lasts approximately 25min
  - Goal: At least 4 responses per word (400 words/400 pseudowords per experiment)
- Participants could participate in up to three sessions

Participants and Data in MALD1.1 (MALD1)

- 353 (232) monolingual Canadian English participants
- 452 (285) total experimental sessions

361,500 (228,000) total button presses

- –about 7 responses per word
- –about 19 responses per pseudoword

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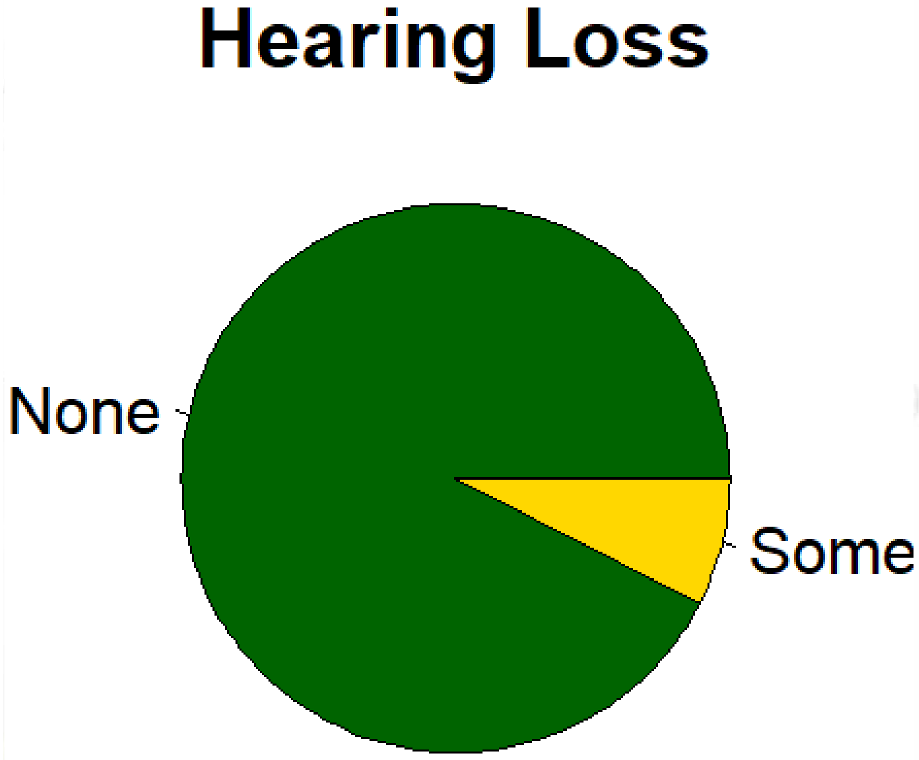
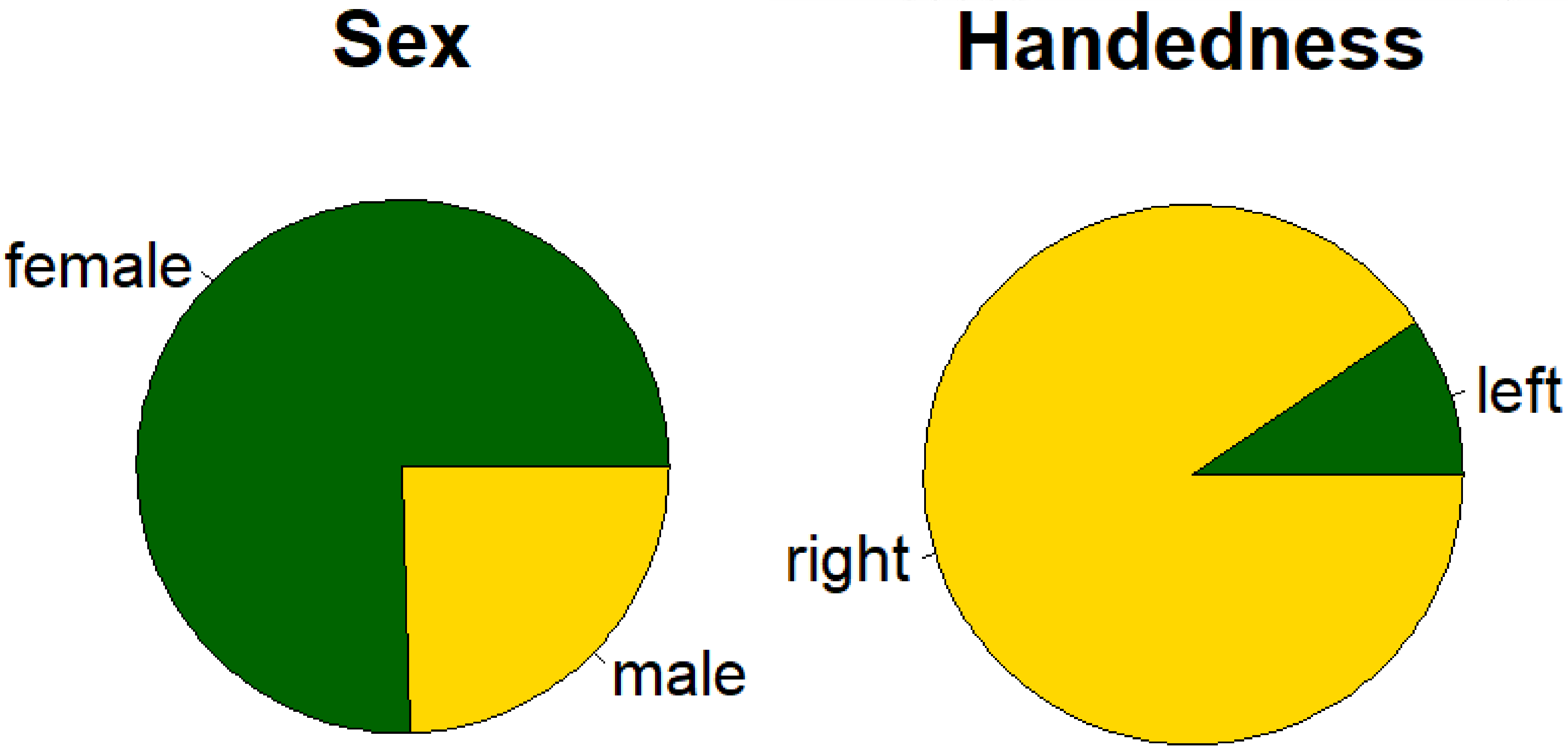
Participant Independent variables

- Age
- Sex
- Handedness
- Native language
- Other languages studied or spoken
- Self-assessed English proficiency
- Education level
- Number of times participated

Participant summary information



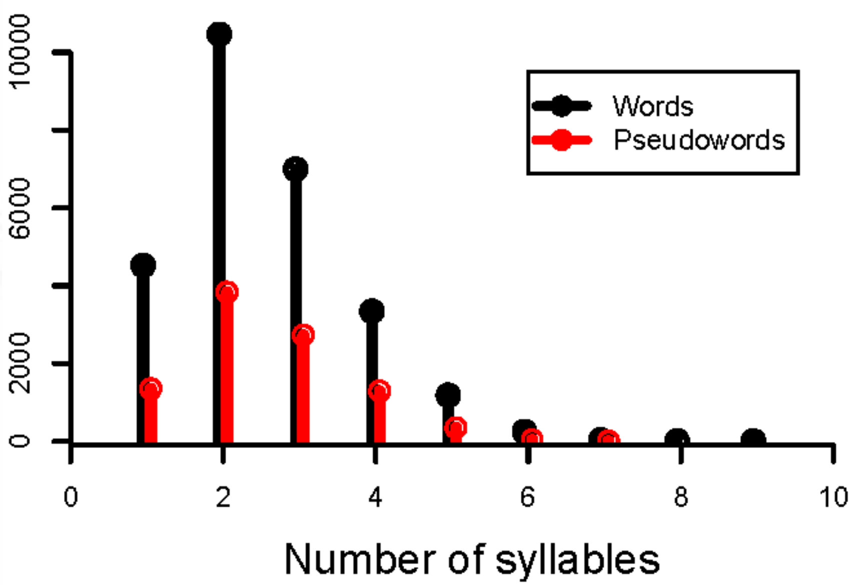
Participant summary information

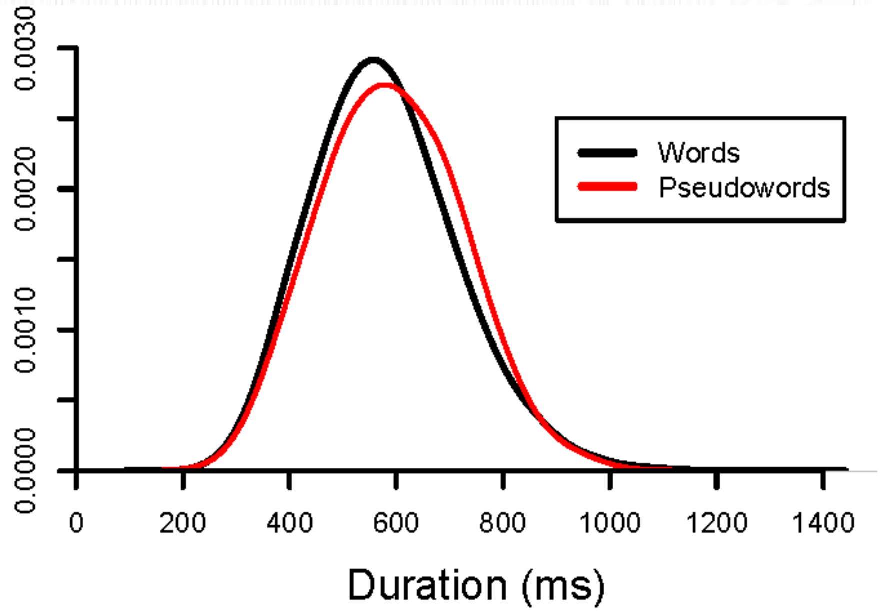


Item Independent variables

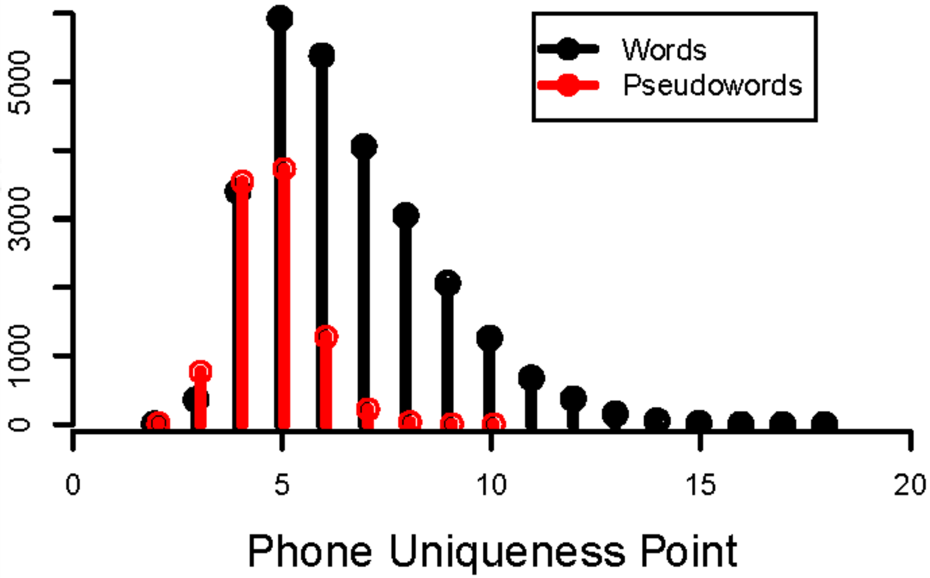
- Word Duration
- Neighborhood Density
- Frequency (COCA, COCA Spoken, Google nGram)
- Pseudoword characteristics (e.g. phonotactic probability, Phonological Neighborhood Density)
- Stress
- Number of Syllables
- Word Run Length

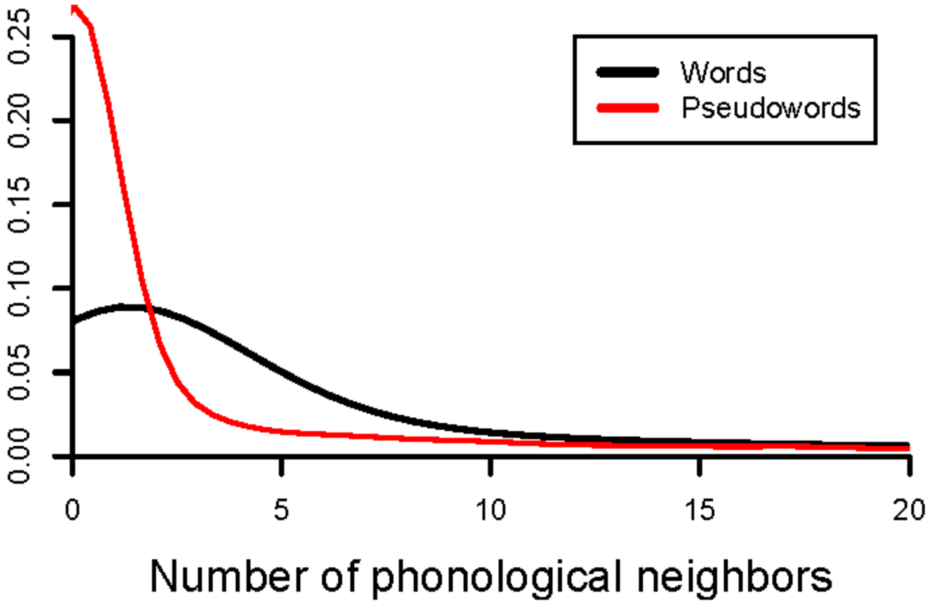
What do we know about the stimuli?



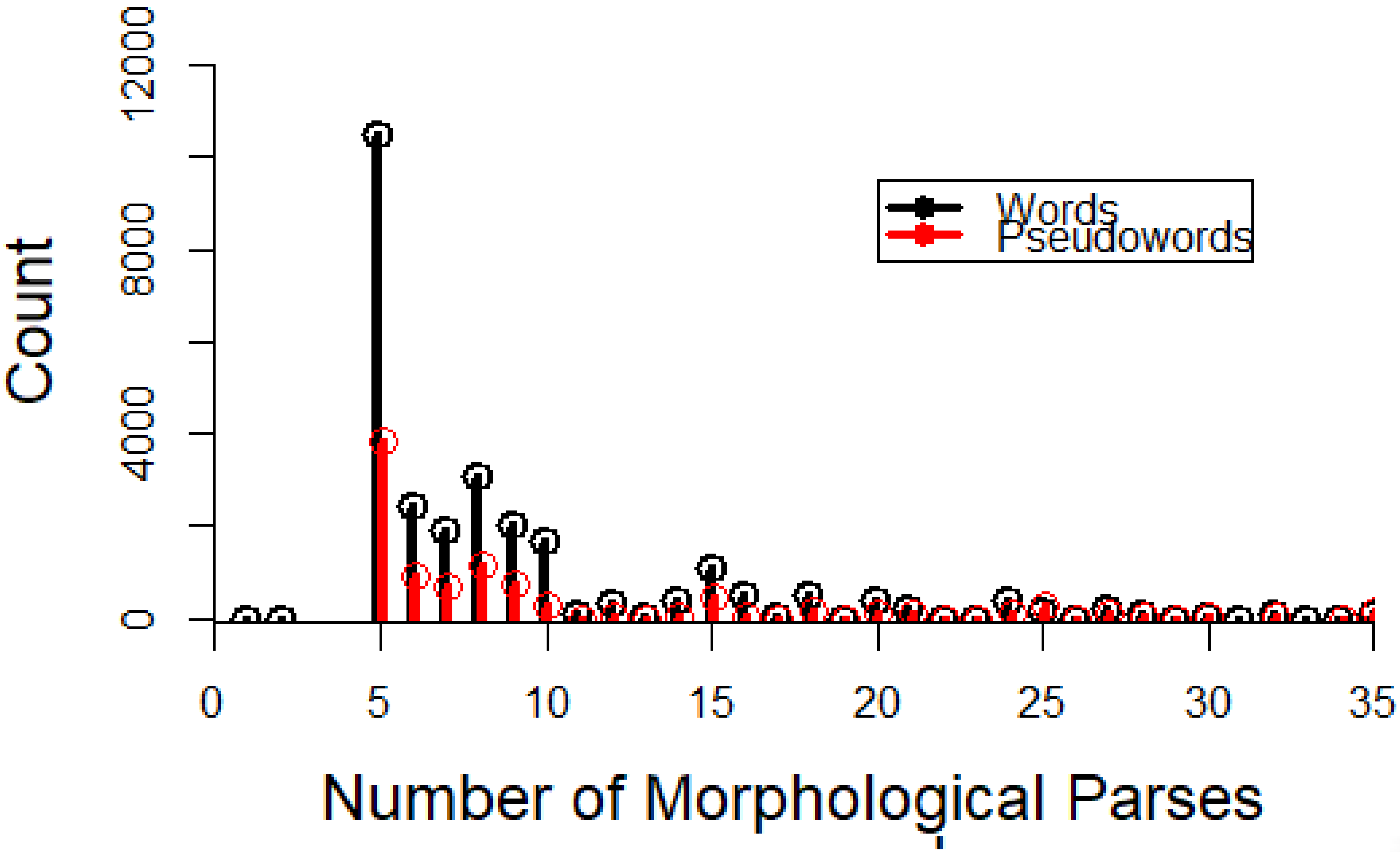


What do we know about the stimuli?





POS and Morphology



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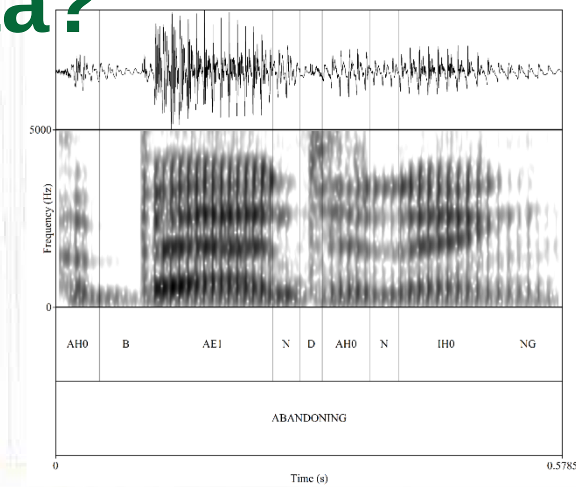
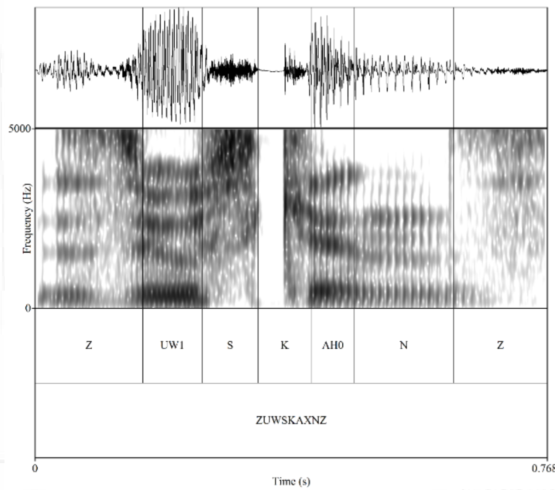
Dependent Variables

- Acoustic characteristics
- Response Latency
- Accuracy

What can we learn from the stimuli - production data?





- We have productions from one speaker producing 26,800 words and 11,400 pseudowords
- 5.88 hours of speech (no pauses) from one speaker!
- The acoustic stimuli become a database of their own

Tucker & Brenner, 2017

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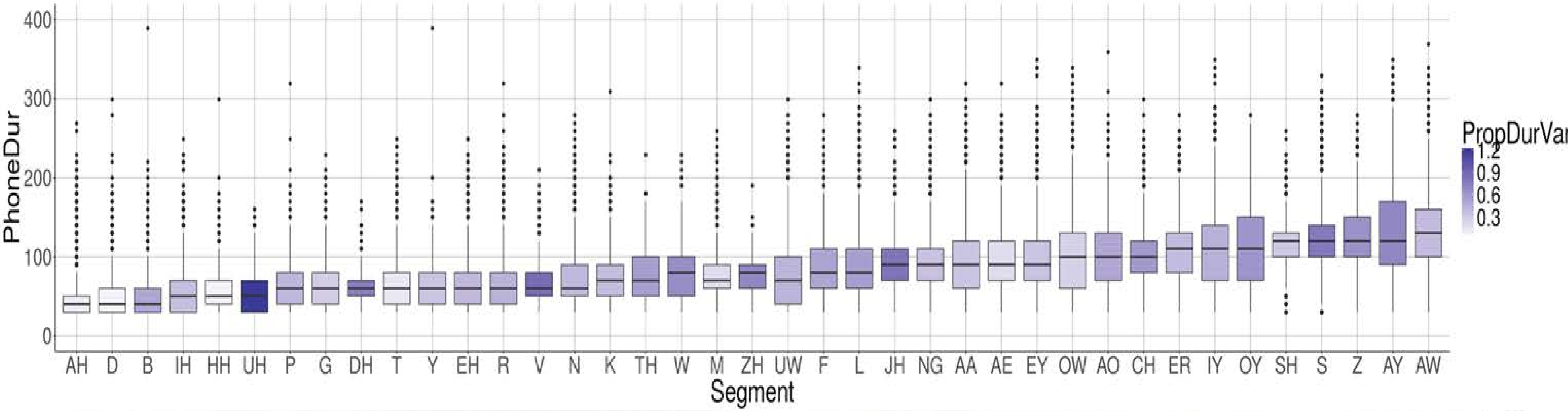
Exploring consonant duration and fricative characteristics



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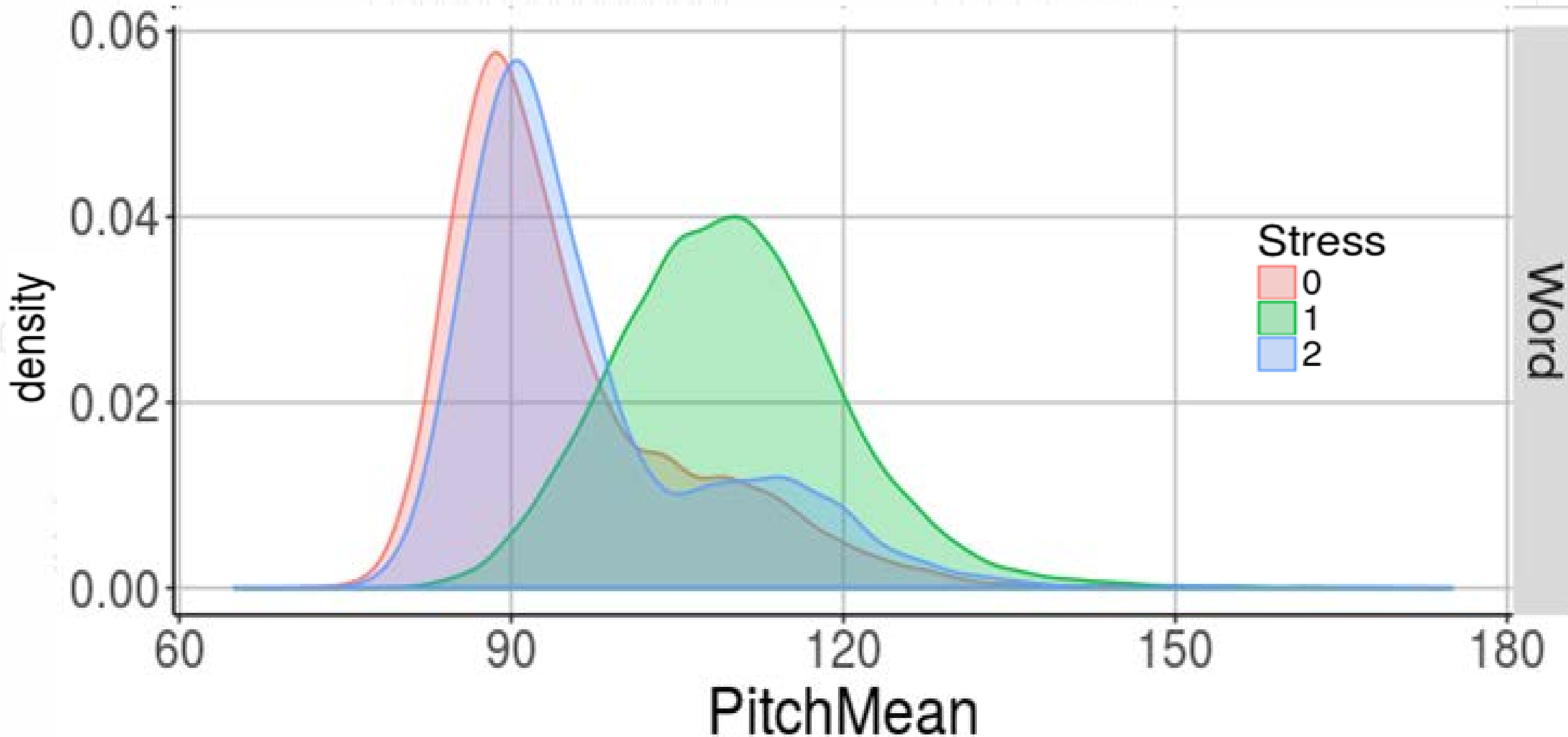
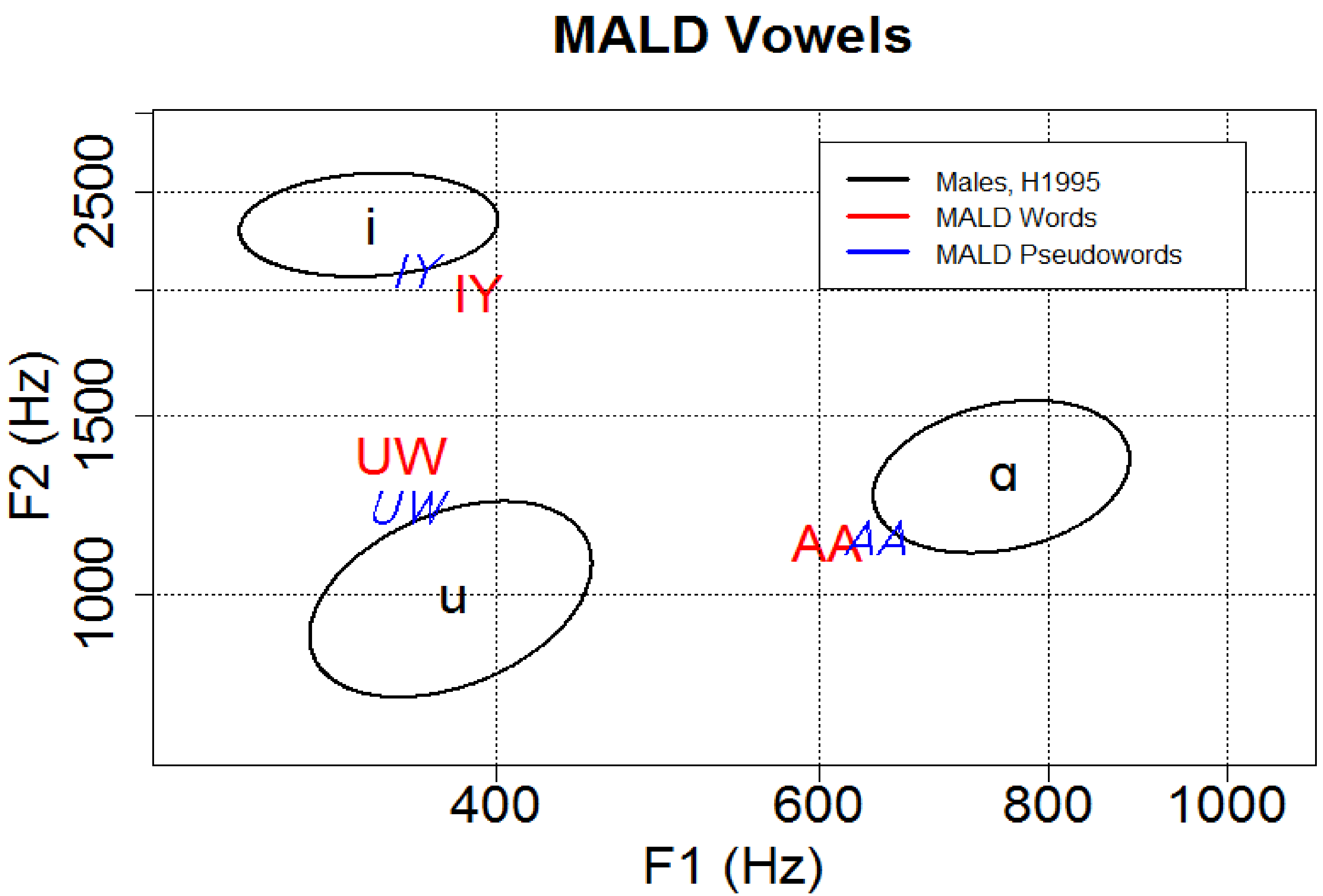
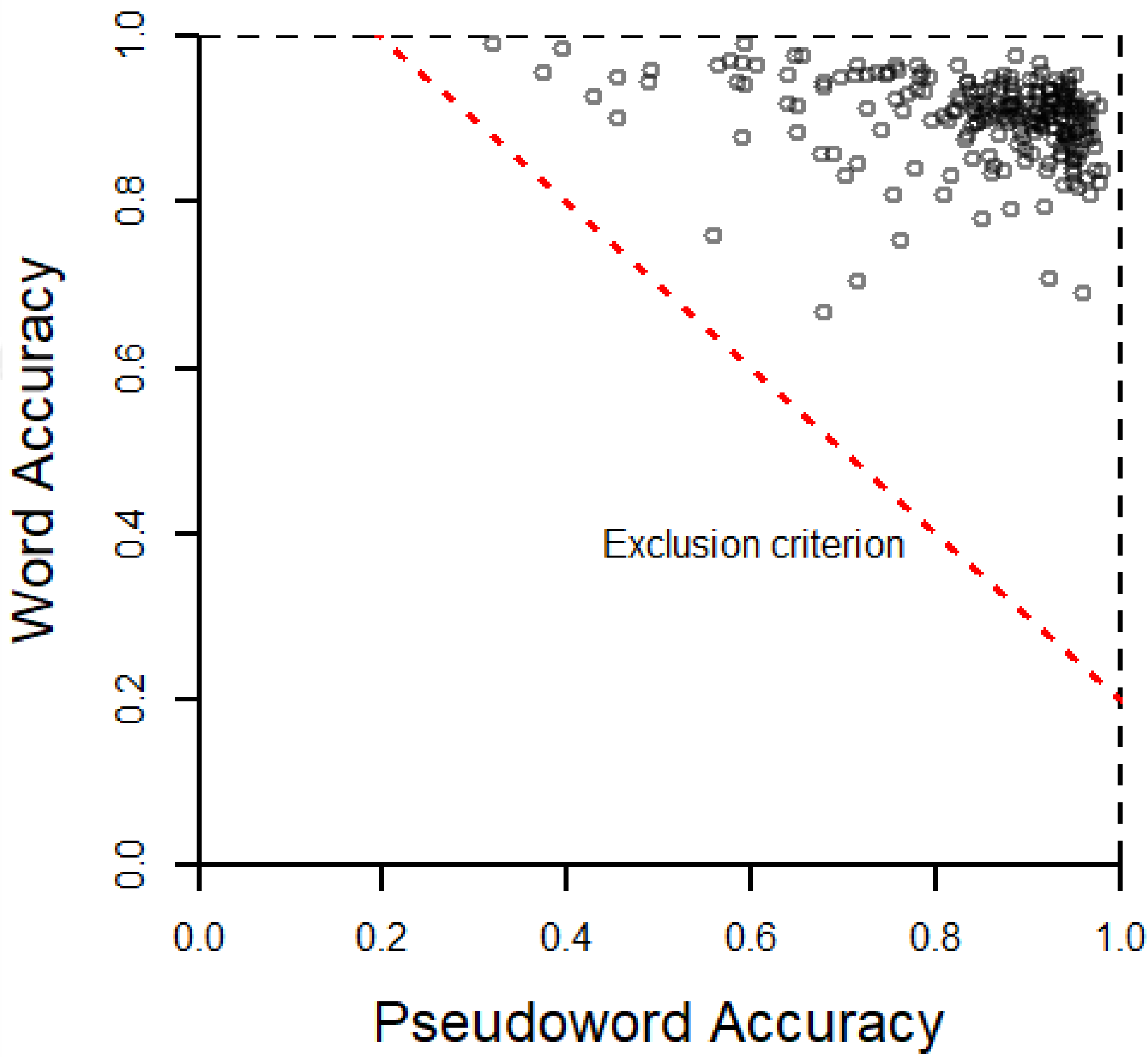
Word duration and Pitch vs. stress

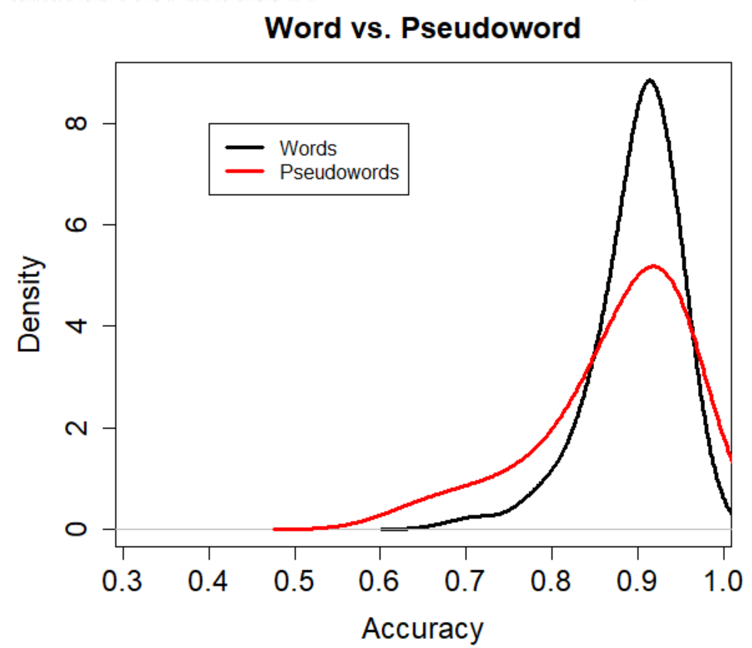


What do our speakers vowels look like?



What is the overall view of participant accuracy?





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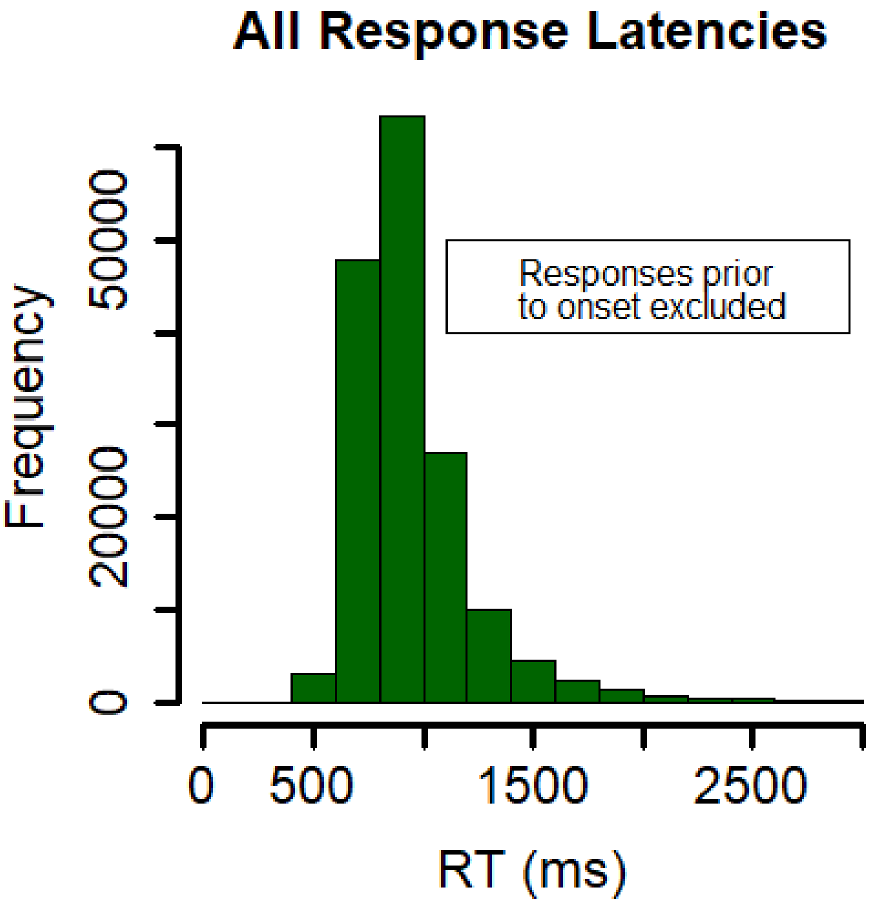
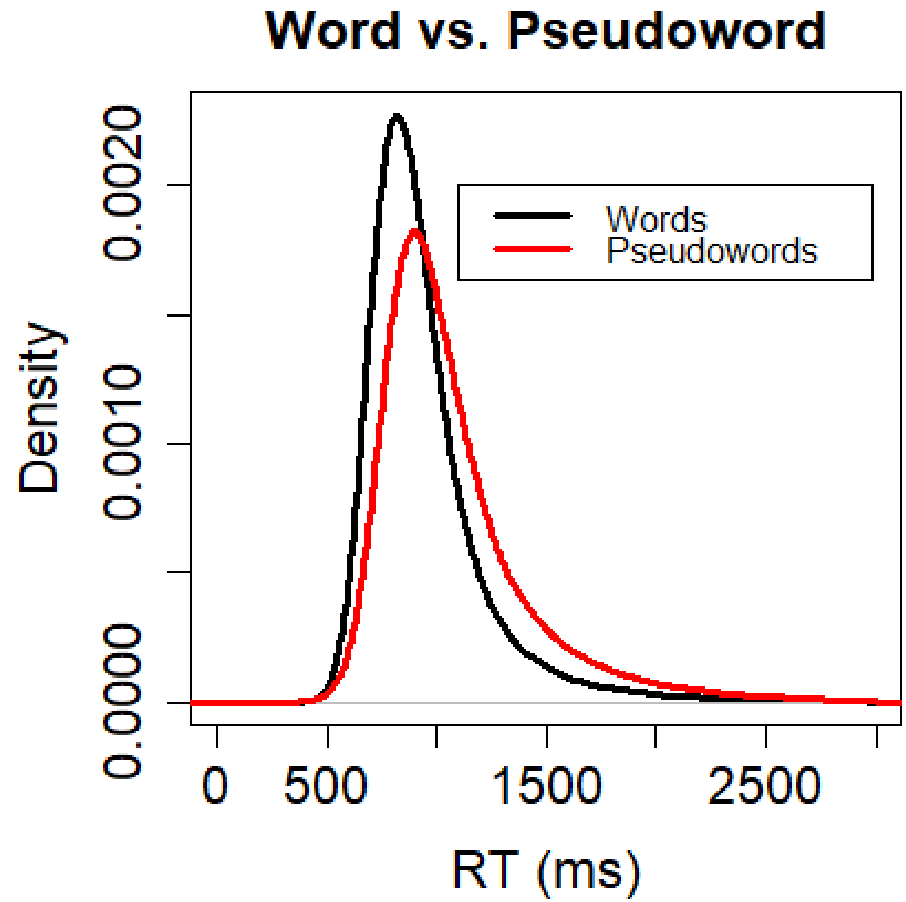
What about response latencies?





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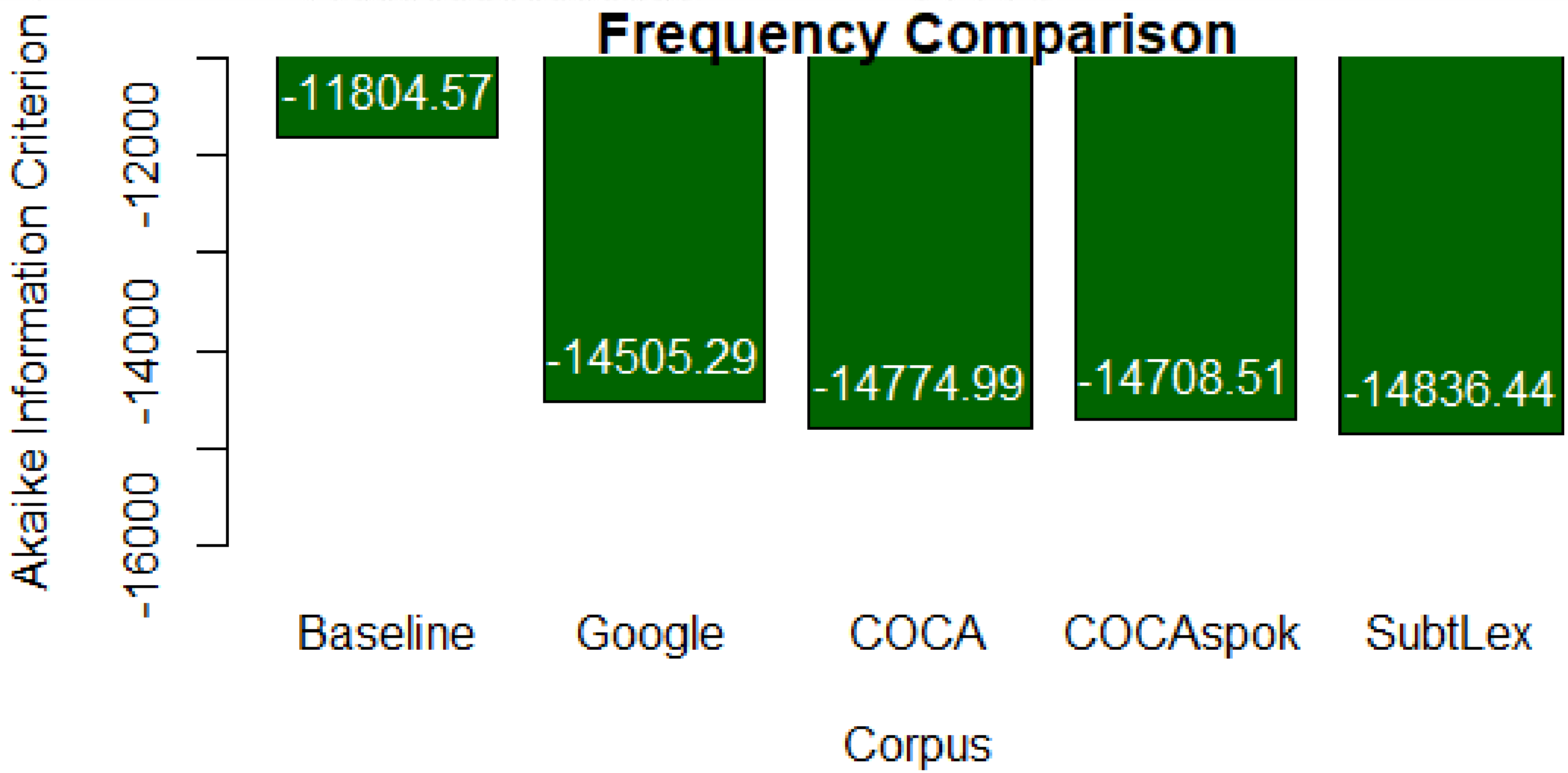
Does the type of frequency matter?



Linear Mixed-Effects Regression

(Tucker, Brenner, Danielson, Kelley, Nenadić, Sims, 2019)

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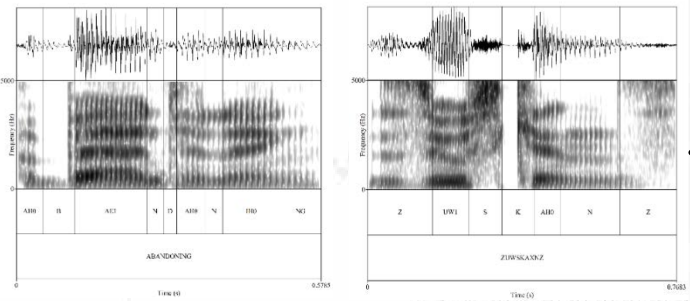

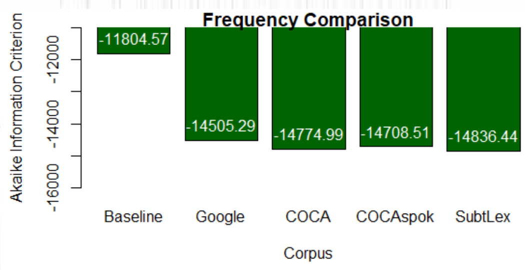

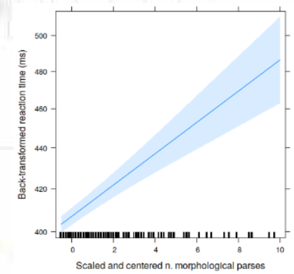

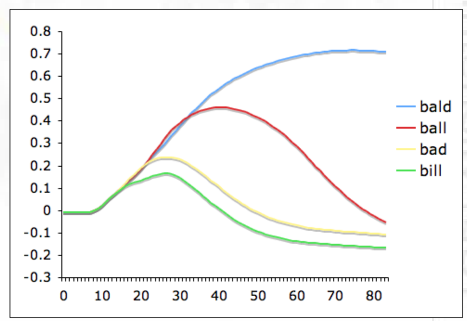

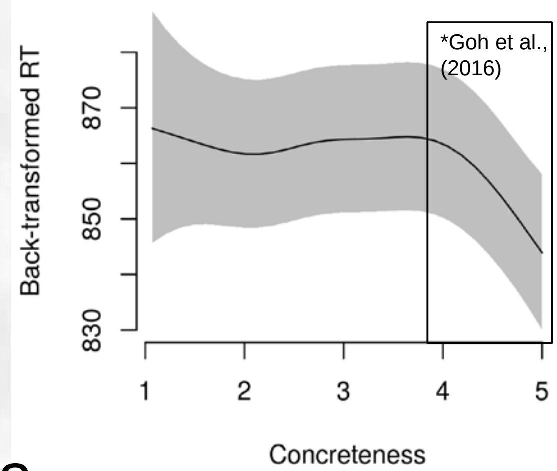

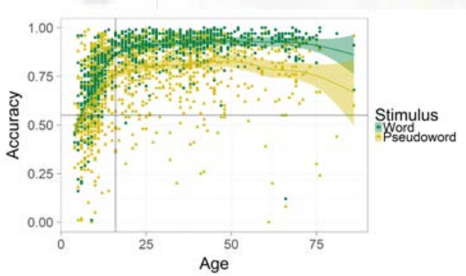

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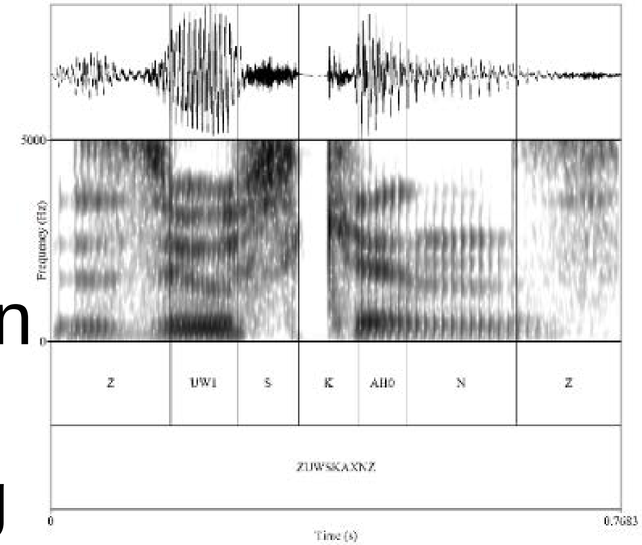
Pseudowords



- Responses to pseudowords often **thrown out**, or else examined to understand real word processing
  - Pseudowords usually represent 50% of responses
- Can we describe some of the processes involved in pseudoword recognition?
  - Hearing a word a listener hasn't encountered before
  - Detecting what's been heard is not a real word (and possibly recovering from that)

(Kelley & Tucker, 2017)

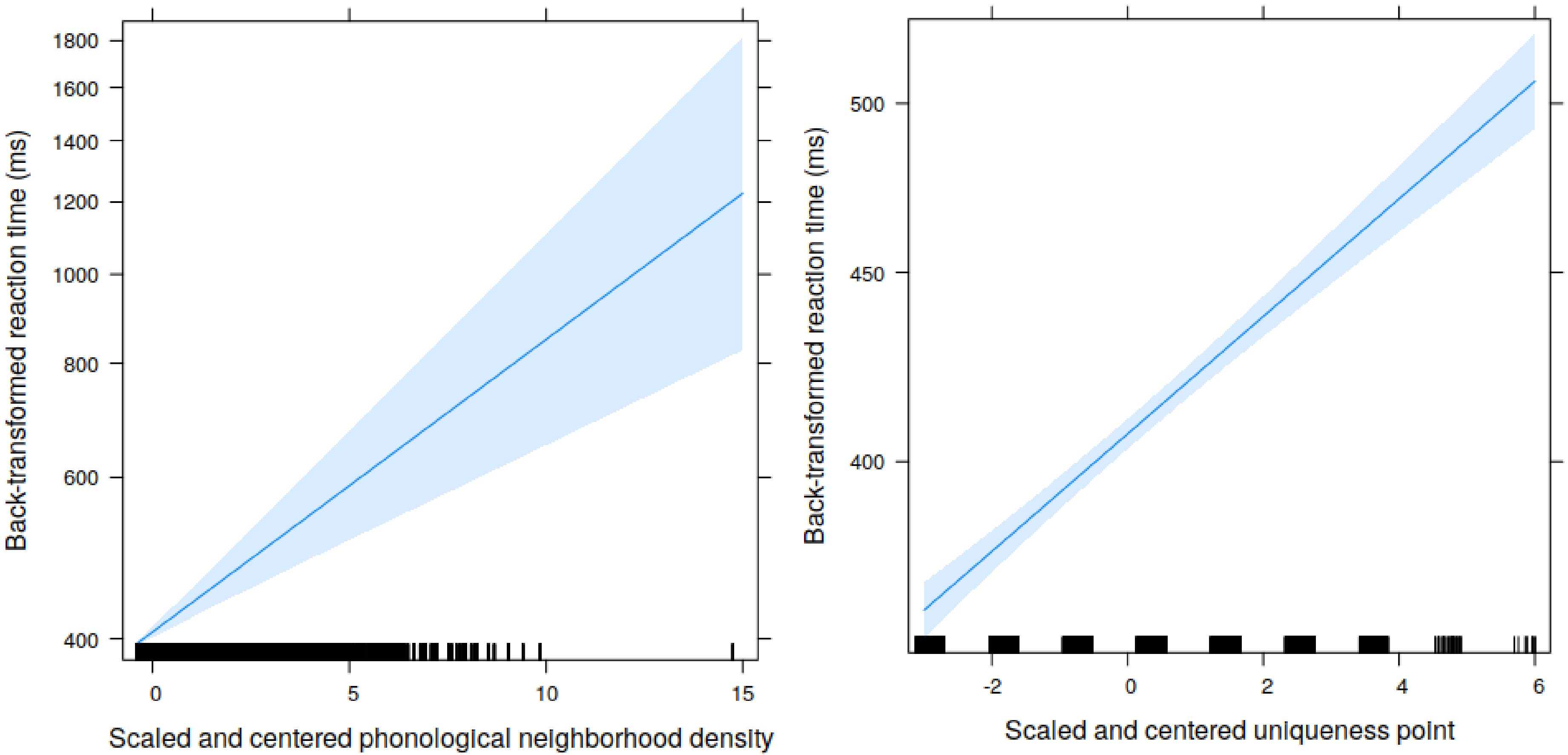
Pseudoword Lexical Predictors and Data

- Phonotactic probability
- Phonological Neighborhood Density
- Uniqueness point
- Morphological Parses

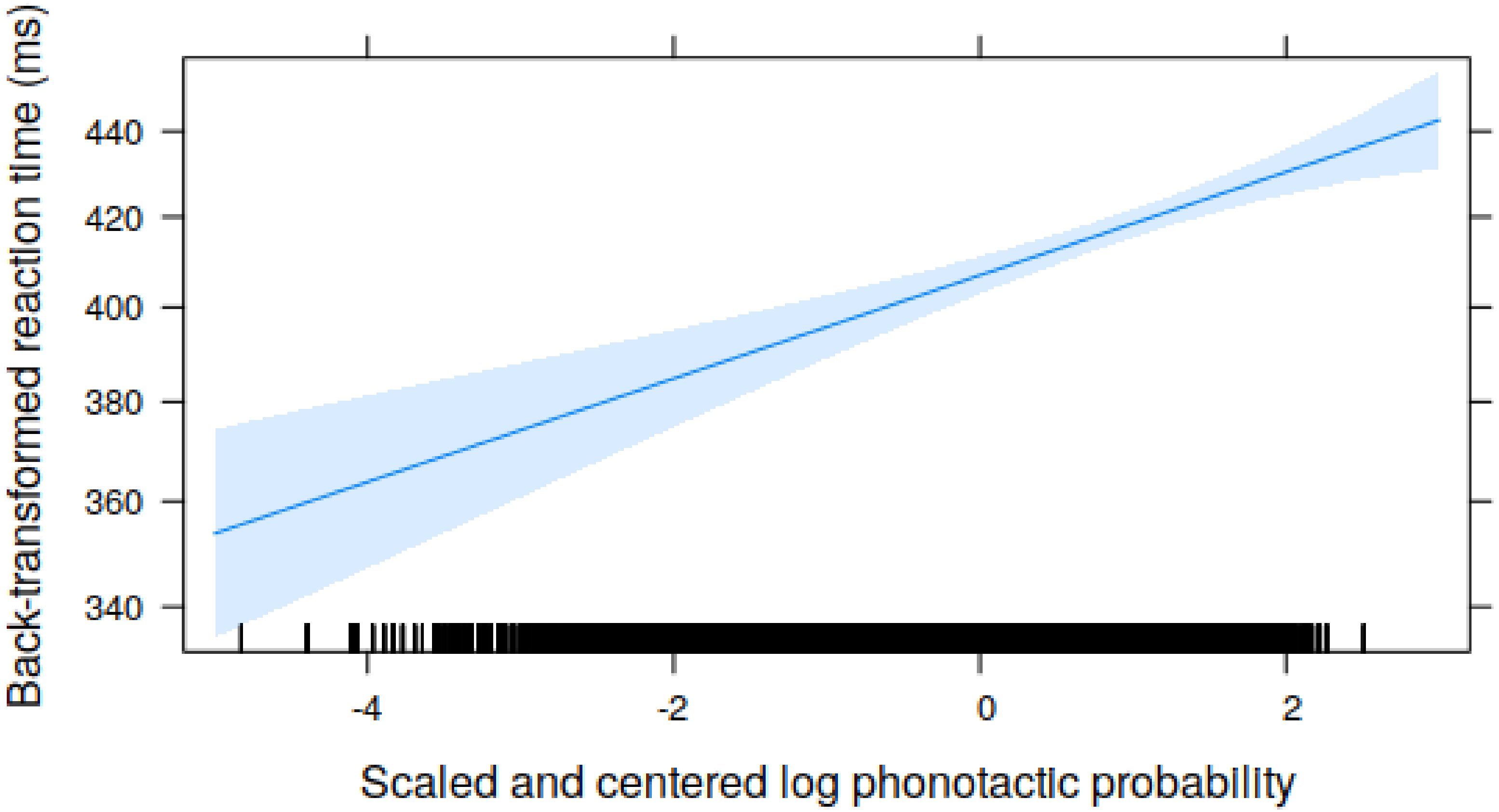
Data

- Correctly identified pseudowords (94,199 responses)
- **Measured from offset**

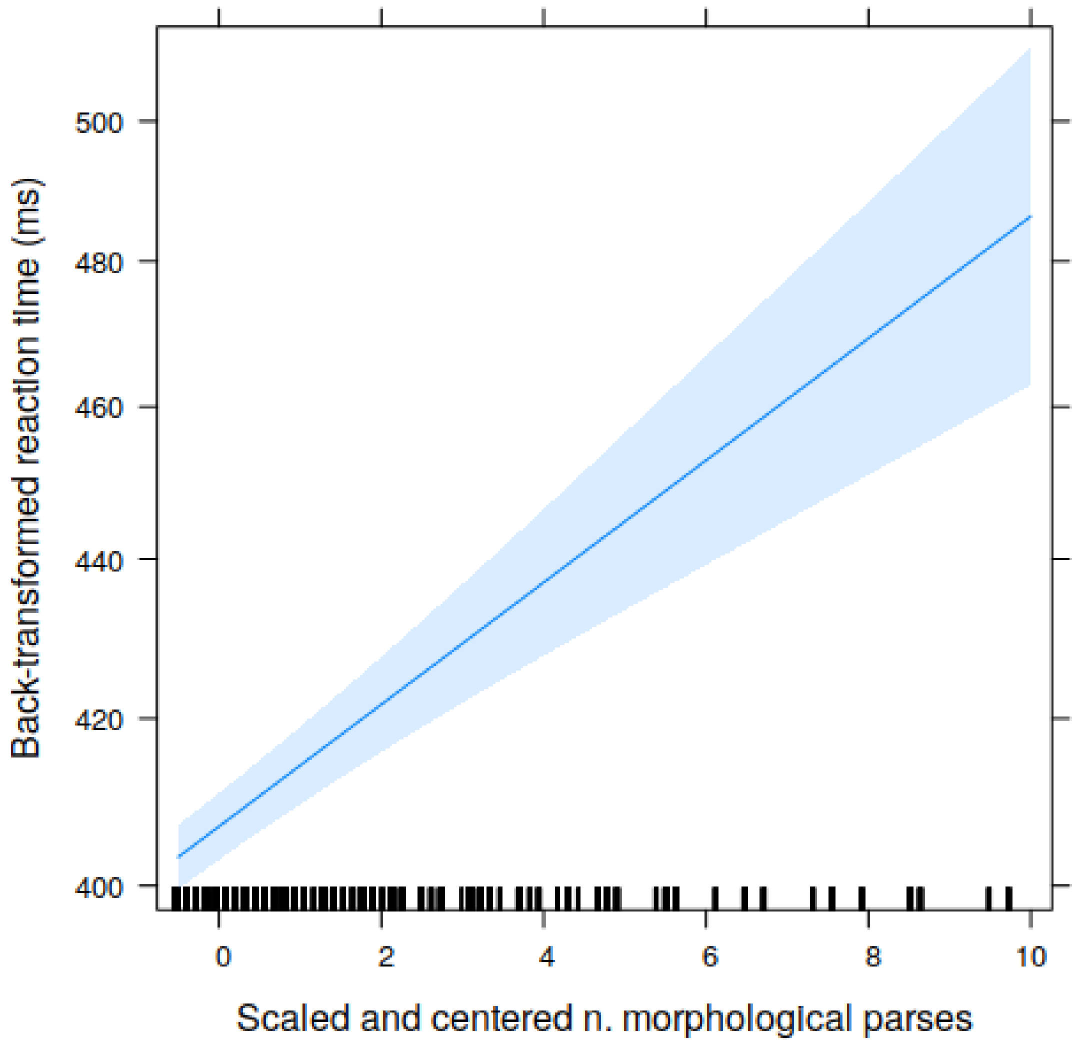
Typical effects of phonological neighborhood density and uniqueness point



Faster responses for low phonotactic probability



Slower responses for words with more morphological parses

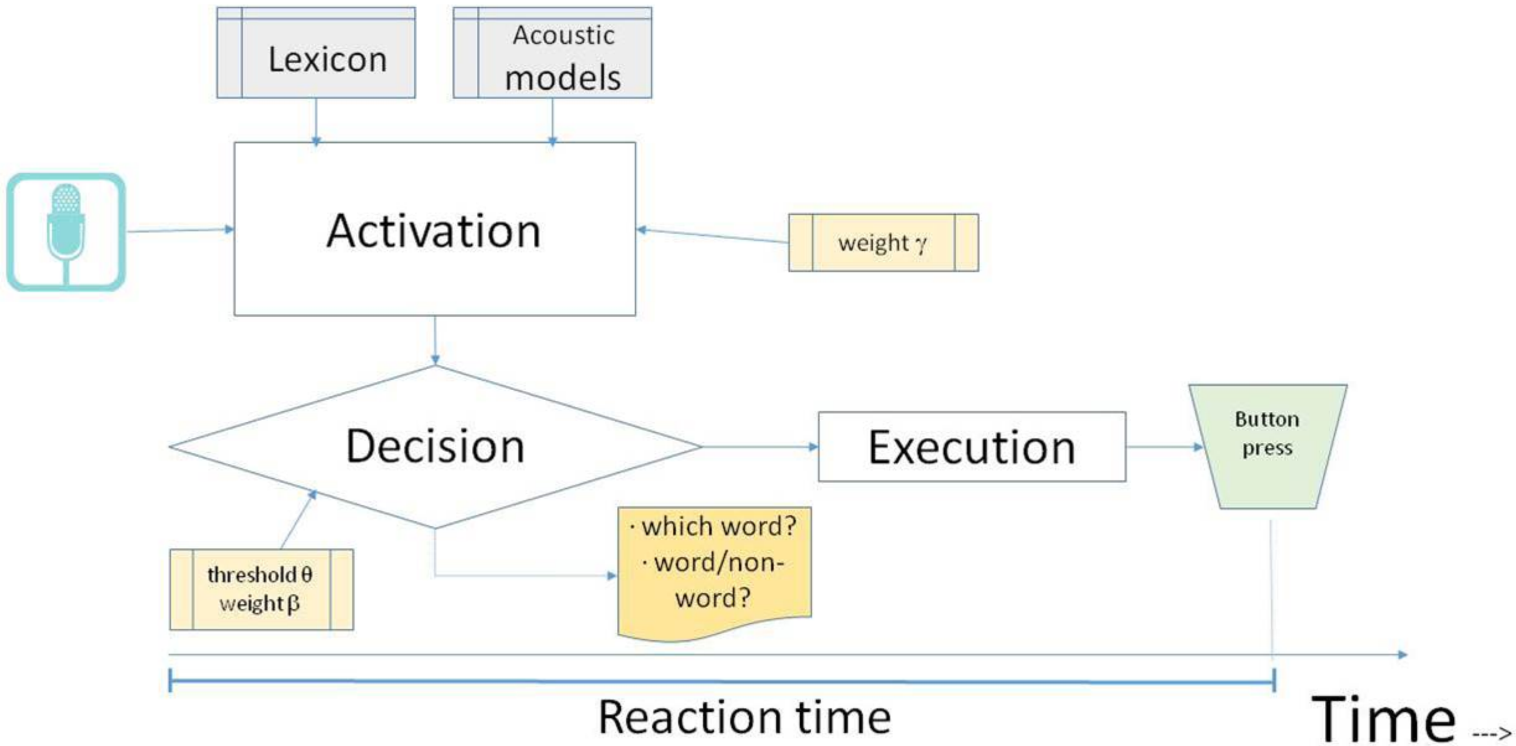


Pseudoword Discussion

There must exist some mechanism to decide if pseudoword is being heard

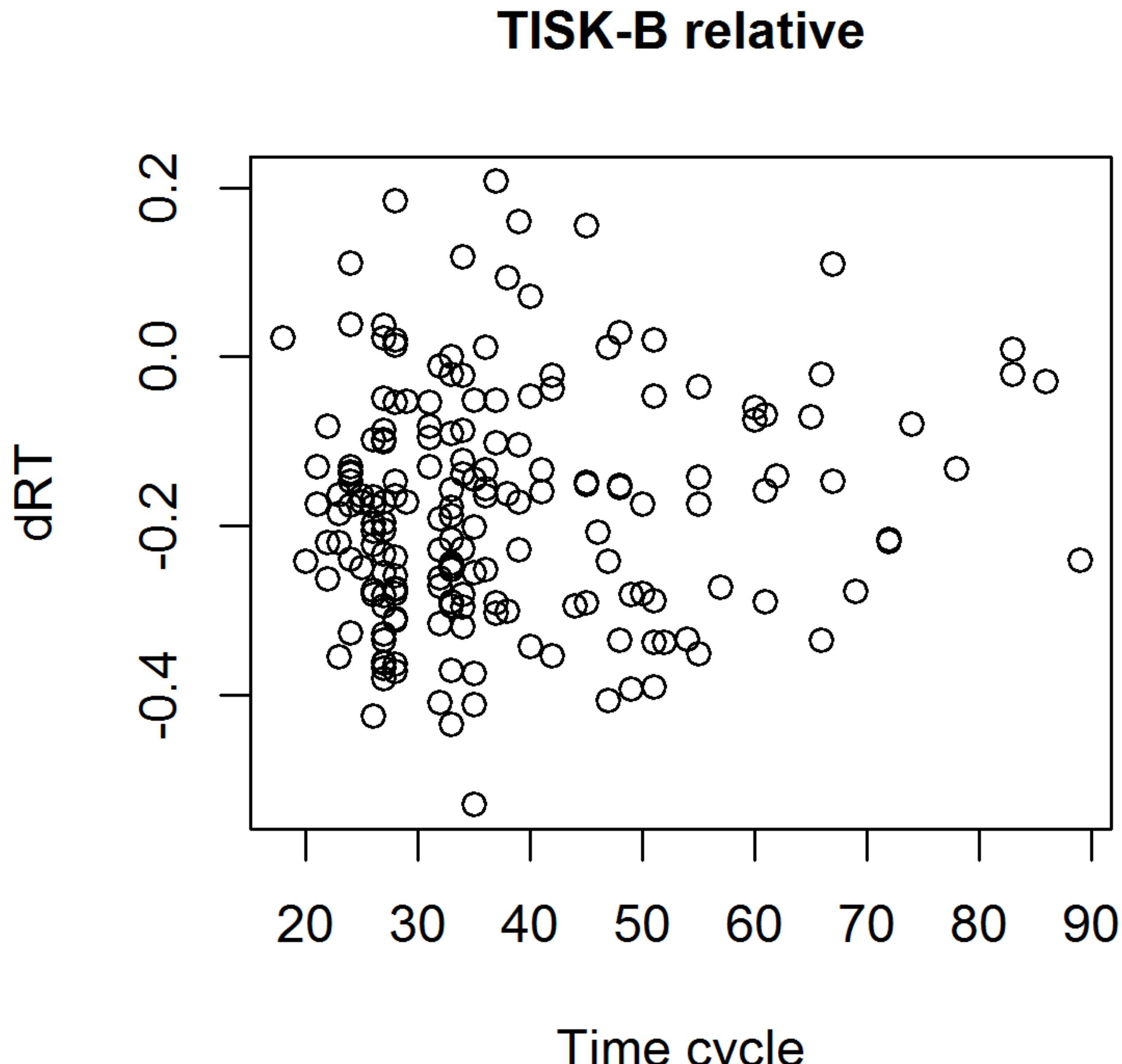
- Unlikely to be organized around one particular characteristic (e.g., phonological neighborhoods)
- Speech processing is going on during pseudoword trials

An end-to-end model of spoken word recognition: DIANA



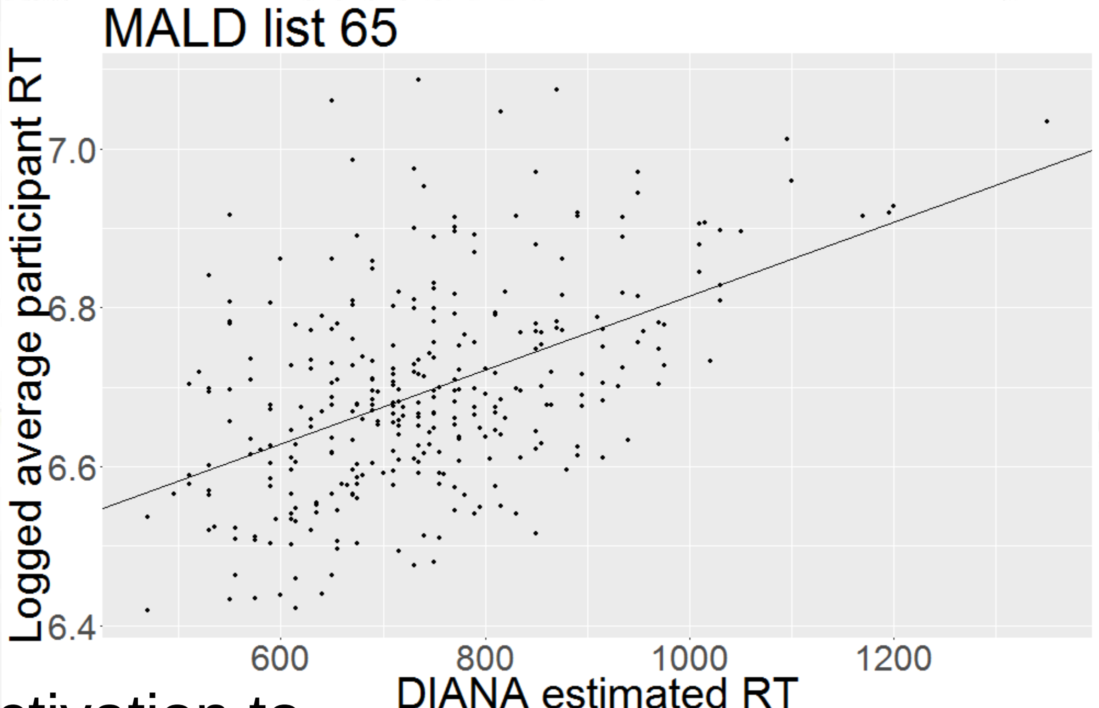
(Nenadić, ten Bosch, & Tucker, 2018)

Word activation and competition



Response latencies estimated by DIANA

Target word	Competitor	Activation
BROWSE (correct)	BROWSE	-2,890.86
	BROWS	-2,890.86
	BROWNS	-2,938.98
	ROUNDS	-2,941.75
ASSURED (incorrect)	USHERED	-4,475.29
	ASSURED	-4,485.90
	ISSUED	-4,522.81
	PRESSURED	-4,549.67



r = .46 when comparing activation to averaged logged participant response latency

More modeling is underway

Semantic Richness (SemRich): a construct encompassing indicators of variability in a given word's meaning

- SemRich effects implicating: *Concreteness*, *Semantic Neighbourhood Density*, *Semantic Diversity*, *Valence*, *Arousal* in visual domain (Pexman et al., 2003; Kuperman et al., 2014)
- Higher SemaRich typically ≈ faster recognition

... little known regarding role of SemRich in *spoken* processing **Goh et al. (2016)**

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Analyze responses to subset of 9,086 words

(had values for the SemRich variables *Concreteness*, *Valence*, *Arousal*, *Semantic Neighborhood Density*, and *Semantic Diversity*)

- ~18-fold increase in items compared to Goh et al. (2016)
- incorporates wider range of values per SemRich variable
- word type not restricted to concrete noun class only (cf. Goh et al., 2016)

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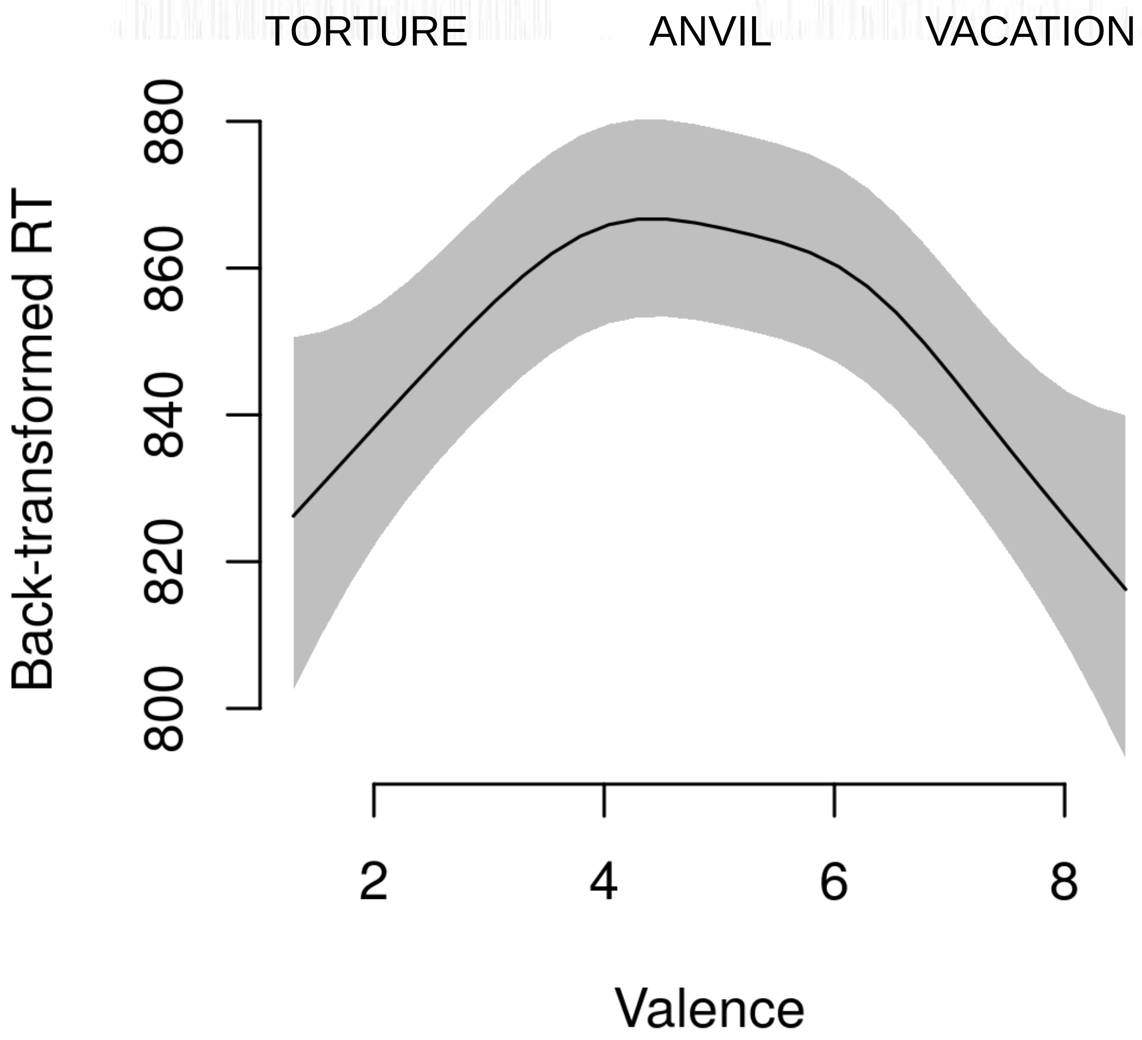
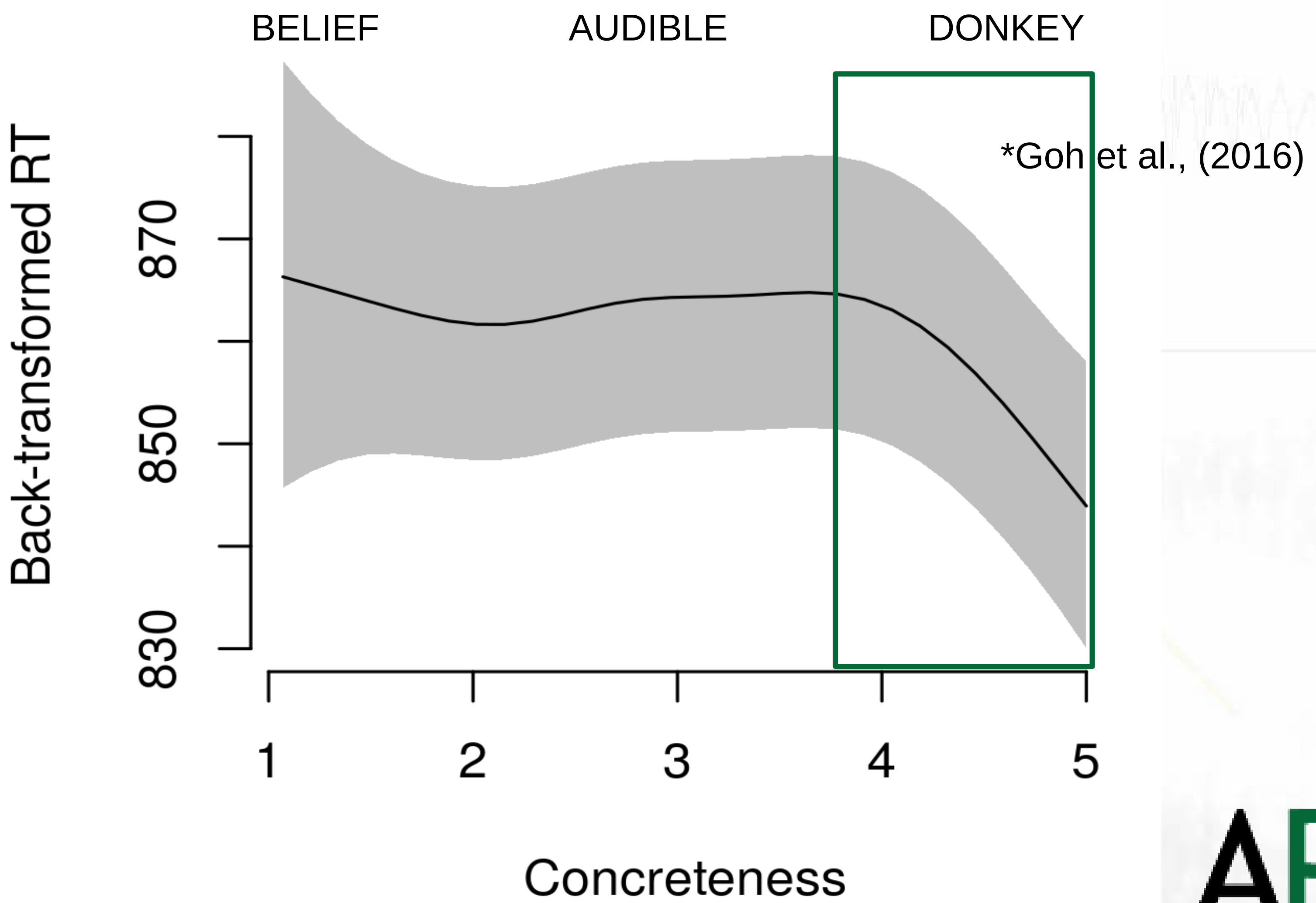
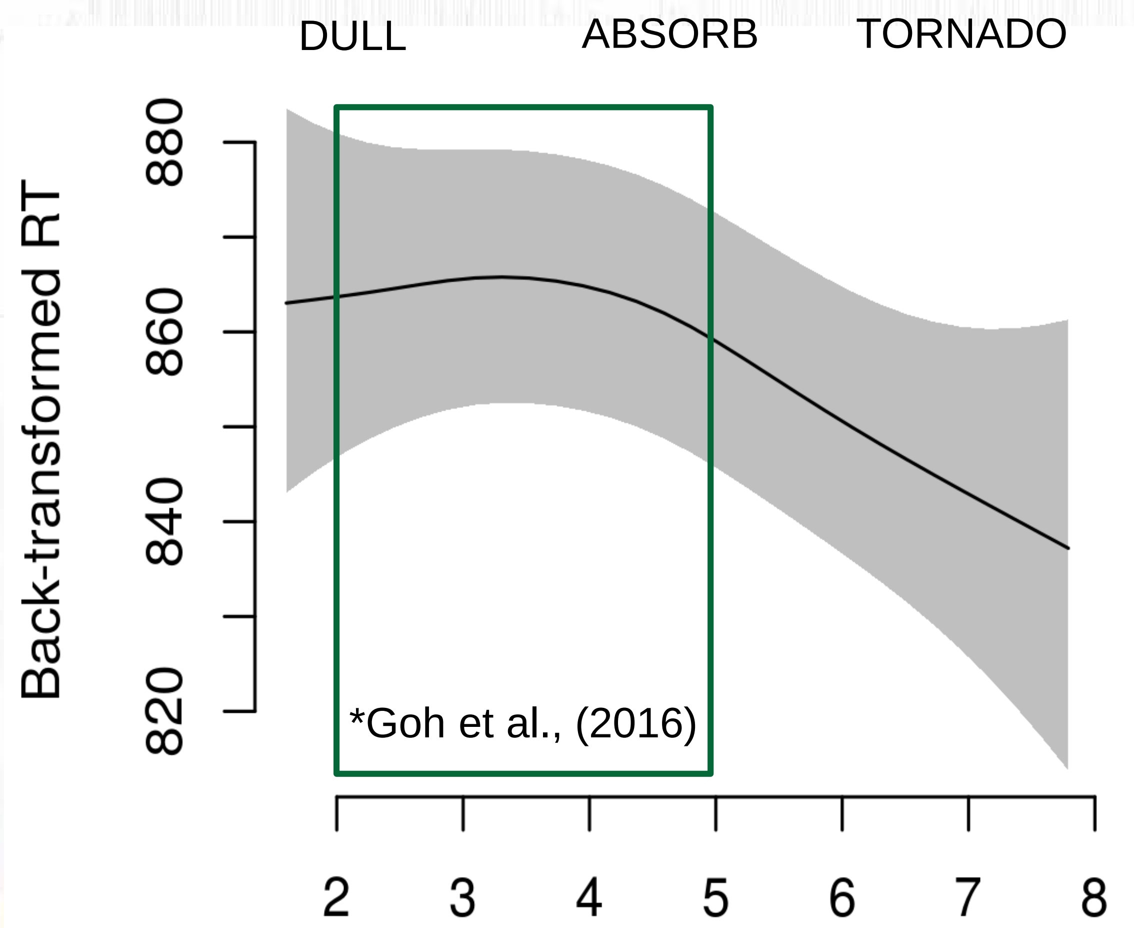
For EXTREME VALUES of *Valence* (both negative and positive) RTs DECREASE



HIGH *Concreteness* is FACILITATORY, but no changes for lower values.



RTs decrease along with **INCREASED levels of *Arousal*, no differences are observed for lower values of *Arousal.***



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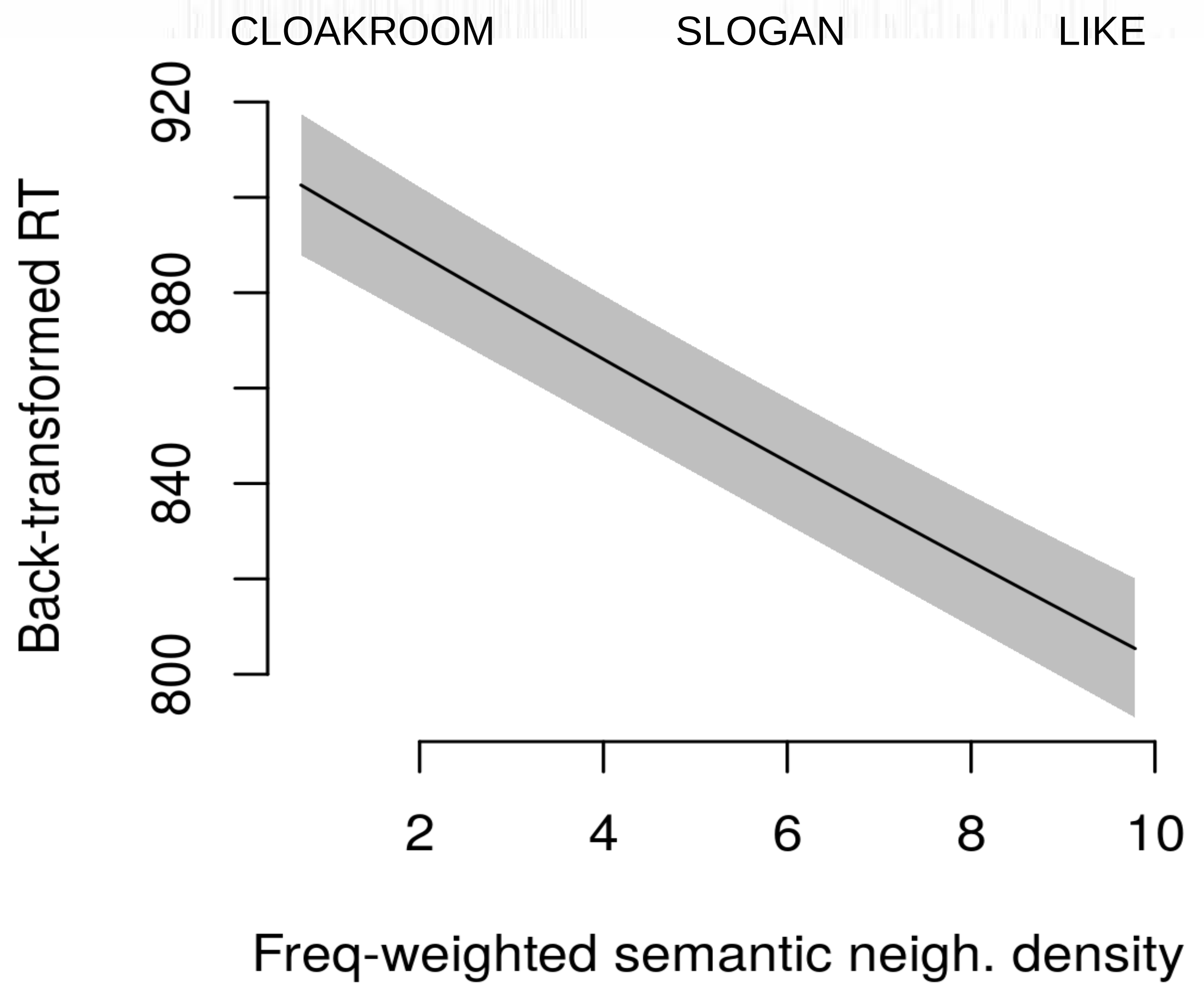
Response Latency Decreases as Semantic ND increases

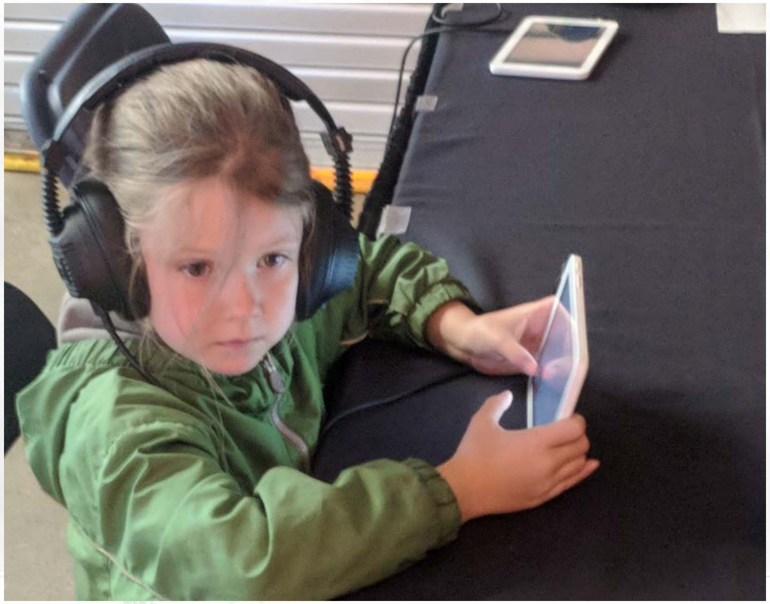


But wait there's more data to come…

- MALD-Biling (Bilinguals, early and late 385)
- Single-MALD (41)
- Expansion of MALD1 (more participants)
- MALD-decades (522 of 1500)
- MALD-Dialects: Arizona (161) & NovaScotia (109)
- sK MALD (female speaker)
  (656 – both bilingual and monolingual)
- sJ MALD (Male speaker 88yo; not yet)

The Science Center: TWOSE-MALD

- 1099 native speakers of English (88.17% monolinguals)
- Age ranged from 4 to 86 (M = 26.74, SD = 17.94), 15 missing data
- 50.77% female, 47.13% male, 1 other, 22 no data



(Laurentzen, Nenadić, Kelley, & Tucker, 2019)

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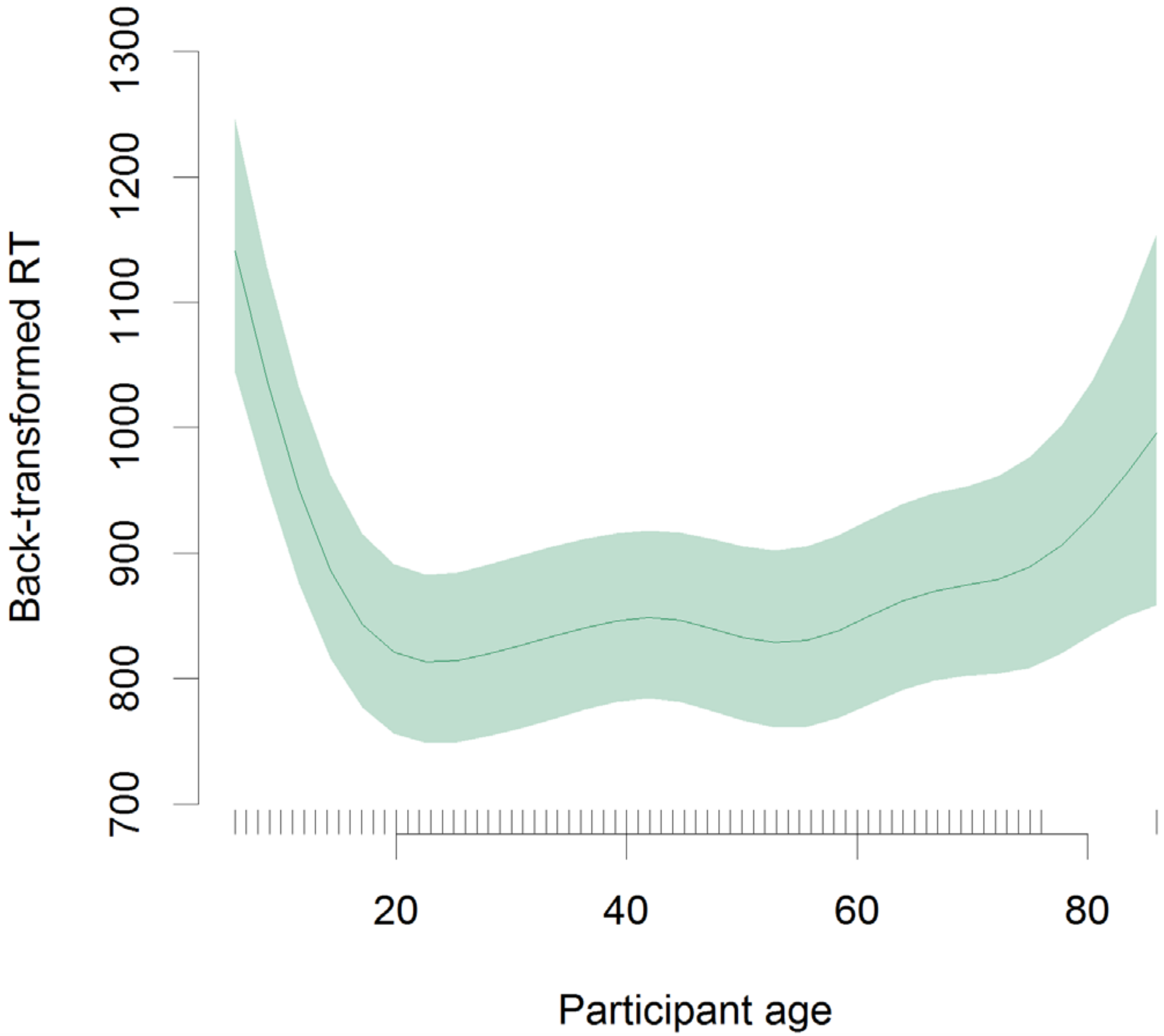
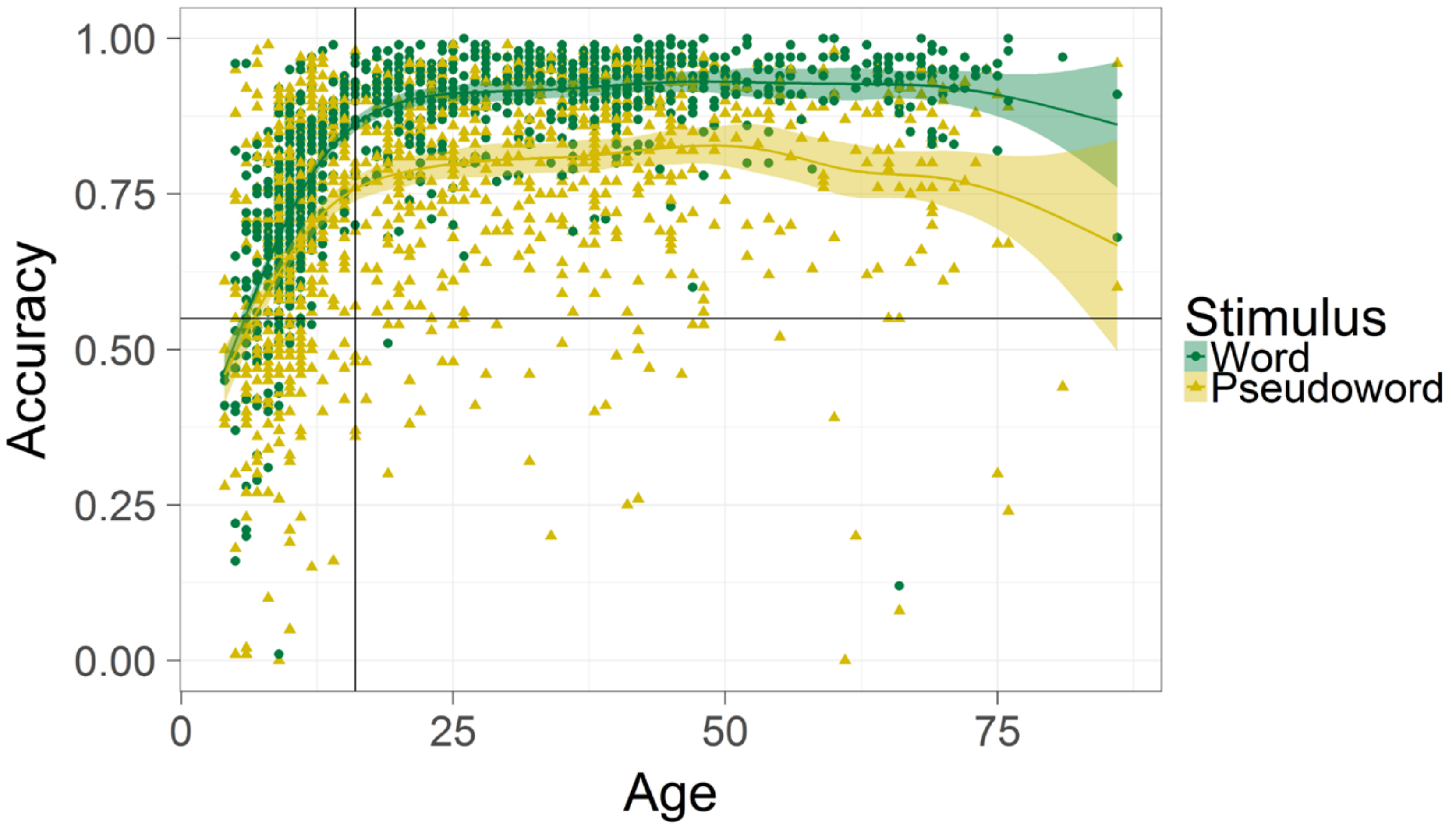
The Science Center: TWOSE-MALD



The Science Center: TWOSE-MALD



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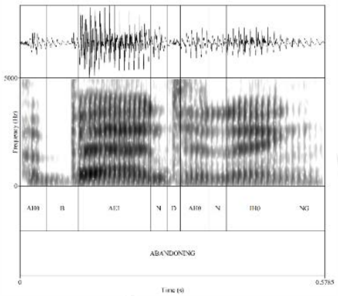

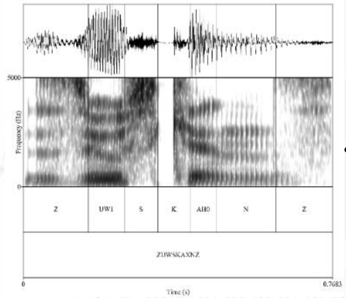

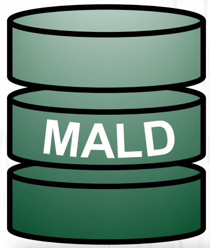

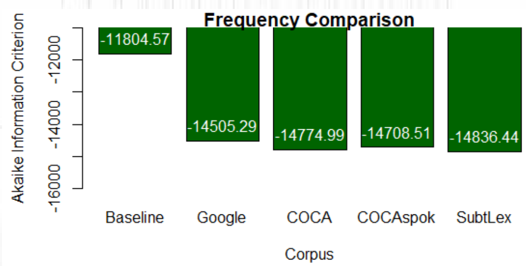

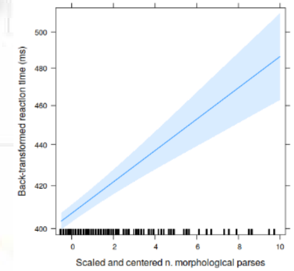

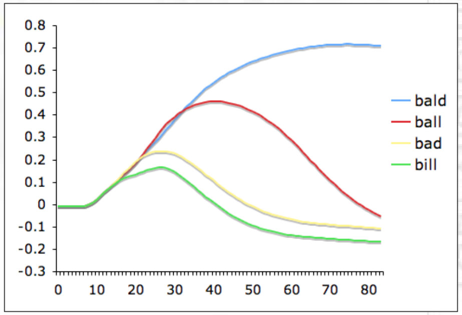

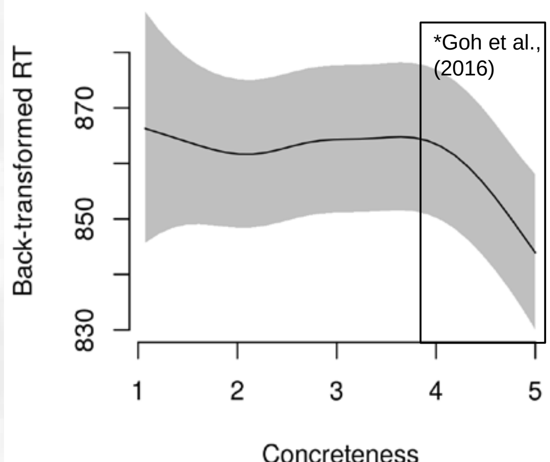

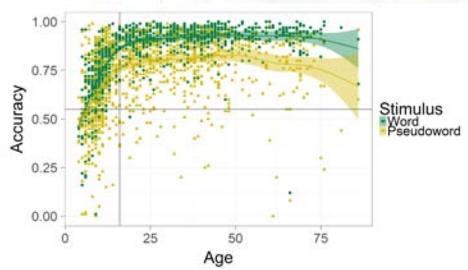

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