Laryngeal timing across seven languages:
phonetic data and their relationship to phonological features

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LSA 2017

Phonological features & phonetic realization

- Settled: ∃ some link (e.g. Jakobson et al., 1952; Clements, 1985; Stevens, 1989; Flemming 1995; Hall, 2001)
- Debated:
  - How direct a link?
  - Related by what criteria?
- Especially for laryngeal contrasts
- phonetic realization greatly differs across
  - Positions (*bat*, *rabid*, *tab*)
  - Languages
    - "True voicing": French, Turkish
    - "Aspirating": German, English

Laryngeal feature theories

- How to capture voicing etc. contrasts, x-ling?

1. Traditional: [±voice]
   - Binary features
   - Indirect phonetics-feature link
     (Lisker & Abramson, 1964; Keating 1984; Lombardi 1991)

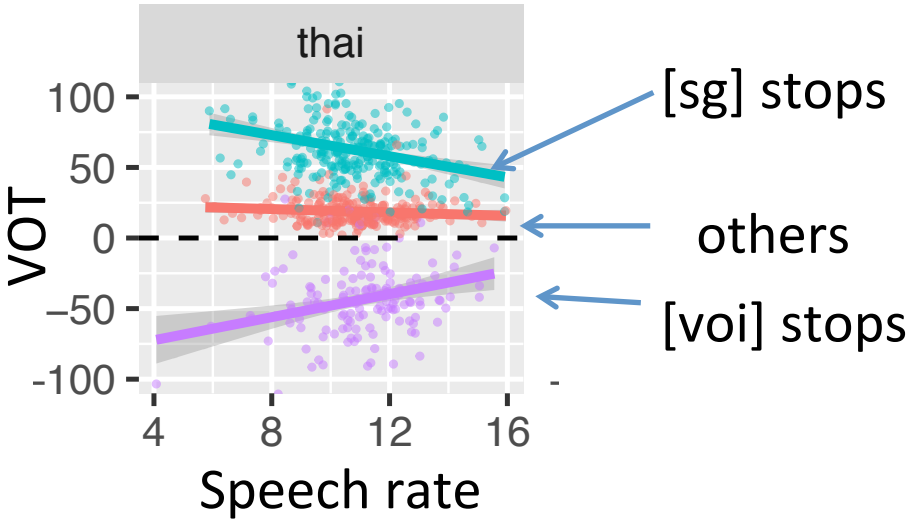
spread, constricted glottis

2. Laryngeal realism: [voi], [sg] (+ [cg])
   - Privative features
   - More direct phonetics/feature link
     (Jakobson, 1949; Iverson & Salmons, 1995 et seq.; Avery & Idsardi 2001)
   - Ex: German: [sg] contrast, French [voi] contrast
     - Traditional: both "voicing contrasts"

Criteria

- LR criteria linking features & phonetic realization

1. Prevoicing
   - [voi] stops vs. others
2. Speech rate ~ VOT
3. Voicing during closure
   - [voi] stops (near 100%) vs. others



(e.g. Jakobson, 1949; Beckman et al., 2011, 2013; Jessen, 2001)

Research questions

- Criteria (1)-(3) often tested in isolation or in 1-2 languages

  (Beckman et al., 2011, 2013; Helgason & Ringen 2008; Jessen, 1998; Lisker & Abramson, 1964; Kessinger & Blumstein, 1997; Ringen & Kulikov 2012)

Swedish, Criterion 2

Many languages, Crit 1

English, French, Thai: Crit 2

German

- Questions: do criteria (1)-(3)
  - hold in a wider sample of languages?
  - give convergent evidence?

- Today: 7 languages, comparable data

Data

- 7 languages:

	Croatian, French, Turkish		Swedish		Thai			German		Korean		
IPA	b	p	b	p^h	b	p	p^h	p	p^h	p^*	p	p^h
Features	[voi]	[ ]	[voi]	[sg]	[voi]	[ ]	[sg]	[ ]	[sg]	[cg]	[ ]	[sg]

Data

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IPA	b	p	b	p^h	b	p	p^h	p	p^h	p^*	p	p^h
Features	[voi]	[ ]	[voi]	[sg]	[voi]	[ ]	[sg]	[ ]	[sg]	[cg]	[ ]	[sg]

"voiced" "voiceless unaspirated" "voiceless aspirated" "tense"

- Read sentences from GlobalPhone corpora
  (Schultz et al. 2013)

Data

Data from two positions:

Utterance-initial (##C)

- Sentence-initial or post-pause pause

Intervocalic (VCV)

- Word-medial
- #*V**C**V*# words

To examine three criteria:

1. Prevoicing
2. Speech rate
3. Voicing during closure

Data: ##C position

- Hand annotated: presence + duration of

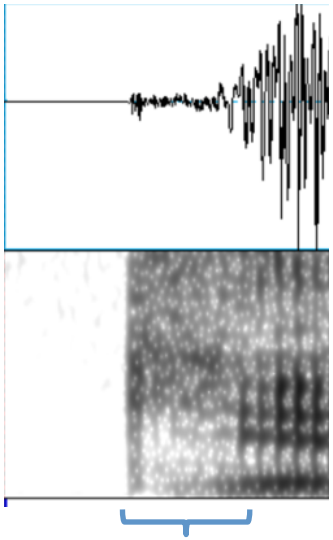
positive VOT + negative VOT ⇒ "VOT"

≈ burst duration = prevoicing

Criterion 2

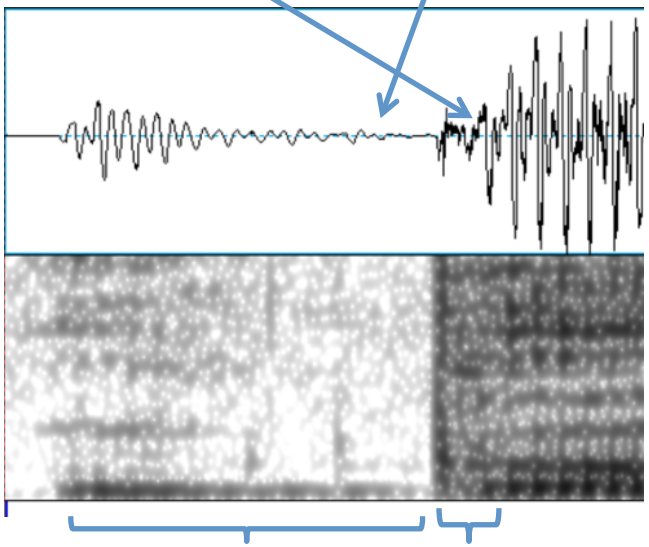
Criterion 1

Turk. ***ge****nsoru*



+ VOT, VOT

French ***ba****nques*



– VOT, VOT + VOT

Exclusions: non-stop realizations, etc.

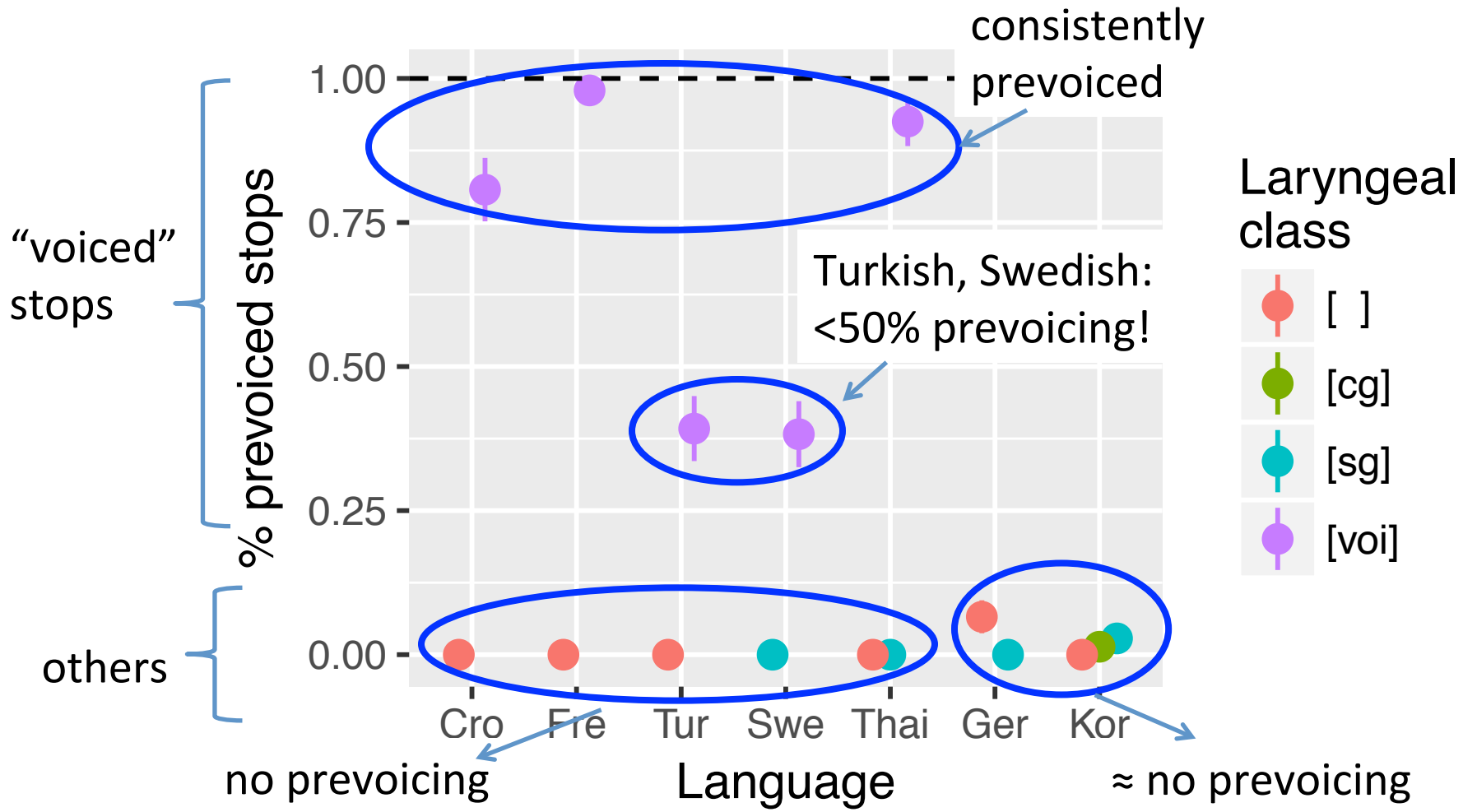
Data: ##C position

	Cro	Fre	Tur	Swe	Thai	Ger	Kor
n	415	549	588	588	616	583	569

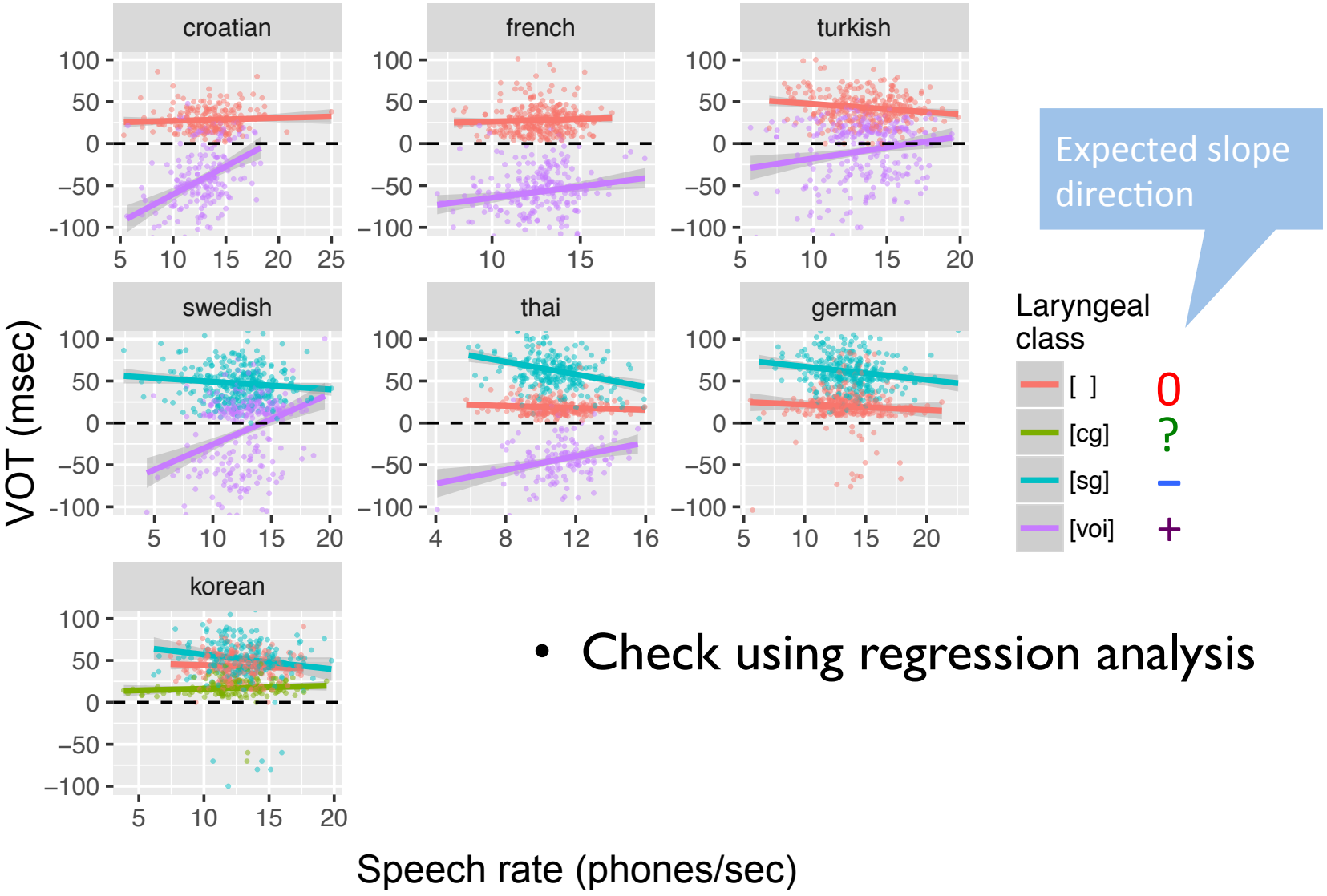
- *n* = 144-311 per laryngeal class/language
  - ≈ balanced by place of articulation
- Speech rate:
  - Phones/second, from forced alignment

Montreal Forced Aligner: Saturday poster

Results: ##C prevoicing

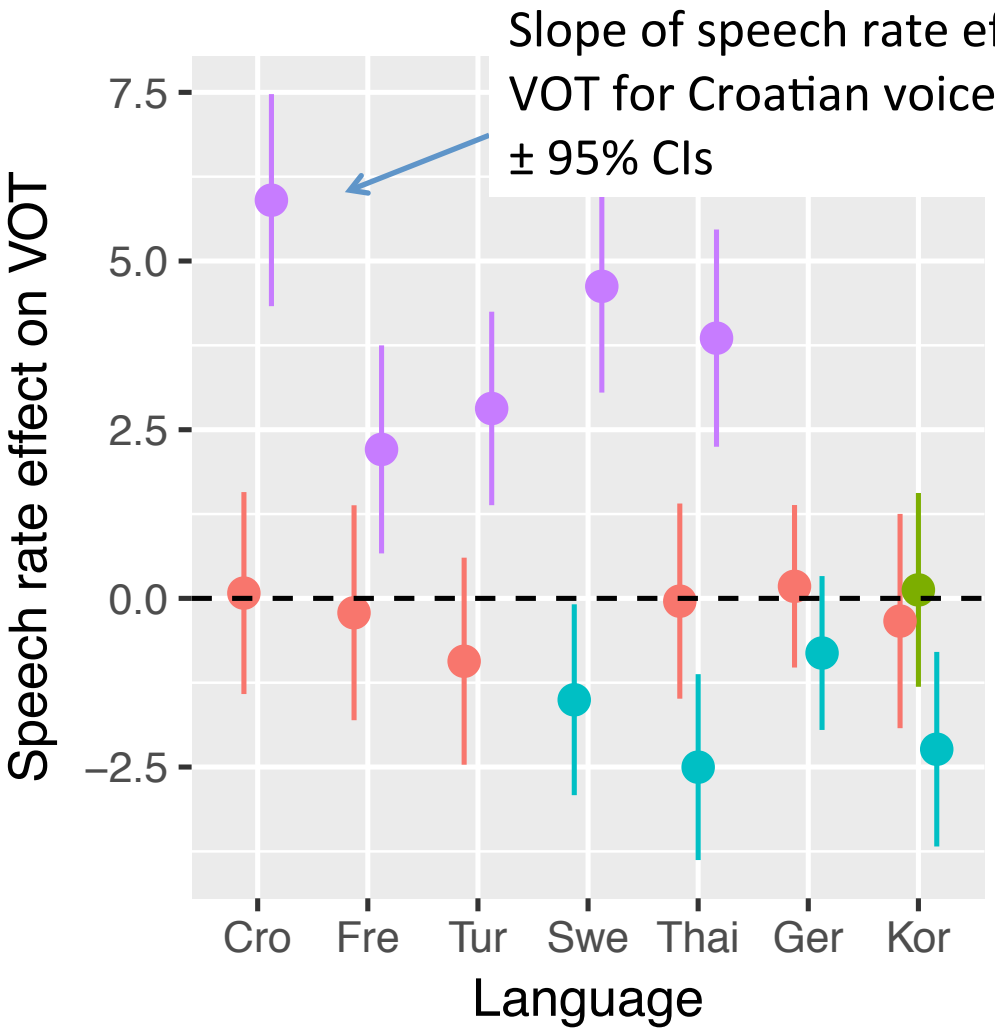


Results: ##C speech rate vs. VOT



- Check using regression analysis

Results: ##C speech rate vs. VOT

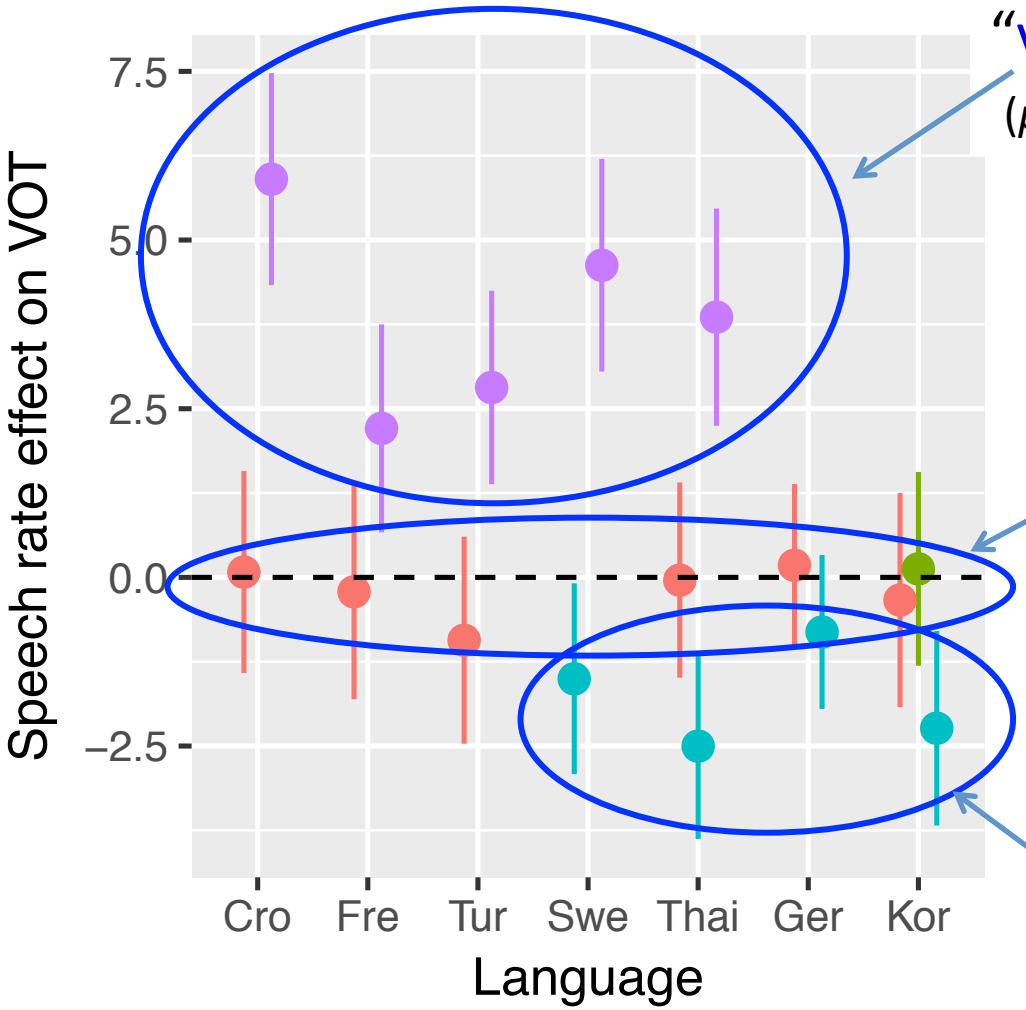


Each language:

- LME regression
- Speech rate x Laryngeal class
- + controls *

* Controls: place of articulation, following segment. By-speaker & by-word random effects.

Results: ##C speech rate vs. VOT



"voiced" stops: positive effect

($p < 0.001$)

Laryngeal class

[ ]

[cg]

[sg]

[voi]

"voiceless unasp" and "tense" stops: n.s.

"aspirated" stops: negative effect

Swedish: $p = 0.04$

German: $p=0.16$

##C position: Summary

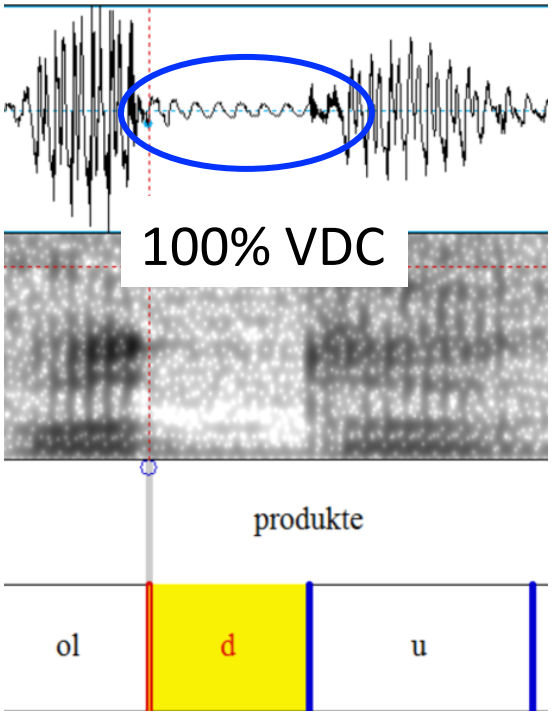
- Criterion 1: prevoicing
  - [voi] stops: ✗
  - non-[voi] stops: ✔
- Criterion 2: speech rate effects on VOT
  - ✔ (mostly)

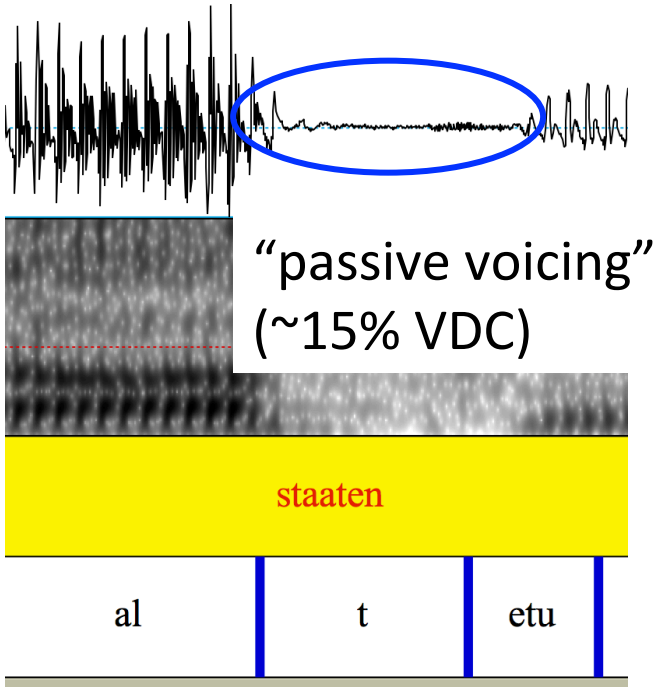
Data: VCV position

Criterion 3

- Hand annotated: percent voicing during closure

Examples: German





Exclusions: Non-stop realizations, adjacent devoiced vowels, etc.

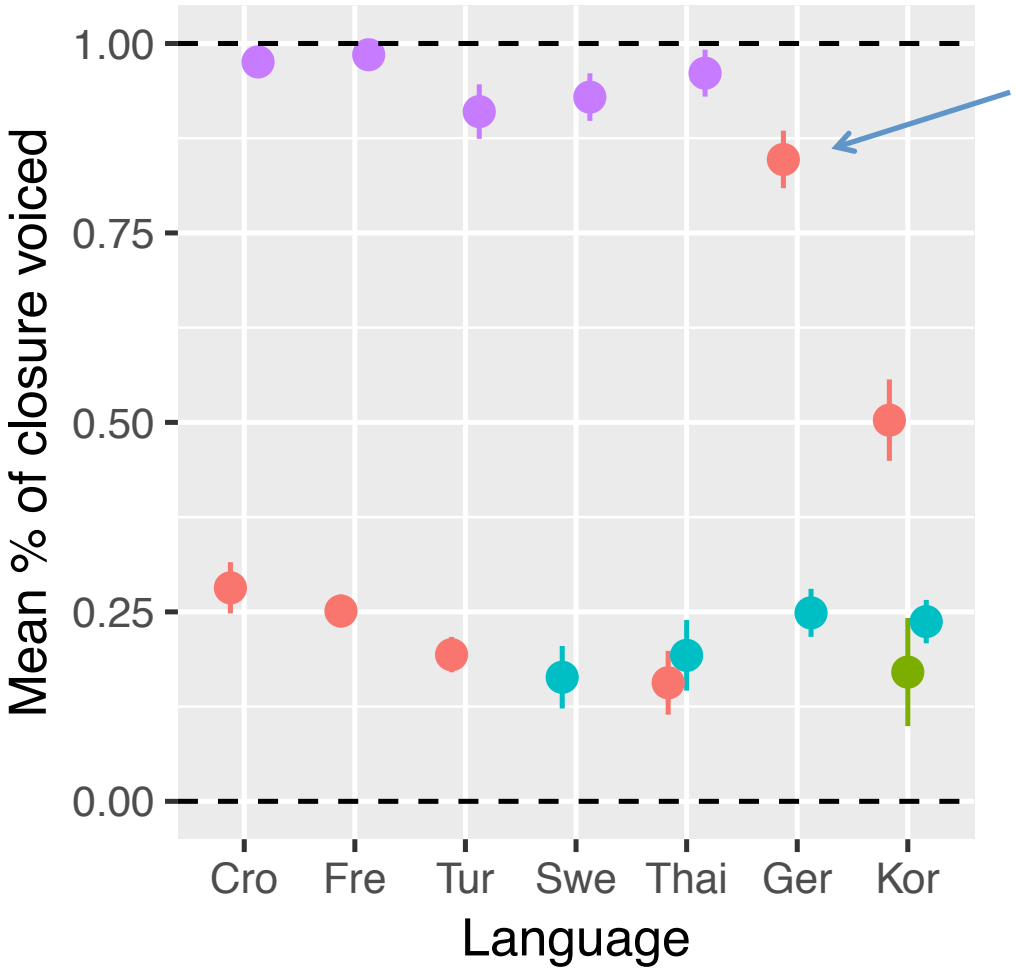
Data: VCV position

	Cro	Fre	Tur	Swe	Thai	Ger	Kor
n	349	367	293	310	344	344	369

- *n* ~ 100-200 per laryngeal class/language
  - ≈ balanced by place of articulation

Data:VCV position

Results: voicing during closure



Mean % of closure voiced for German lenis/voiceless unaspirated stops ± 95% CIs

Laryngeal class

[ ]
[cg]
[sg]
[voi]

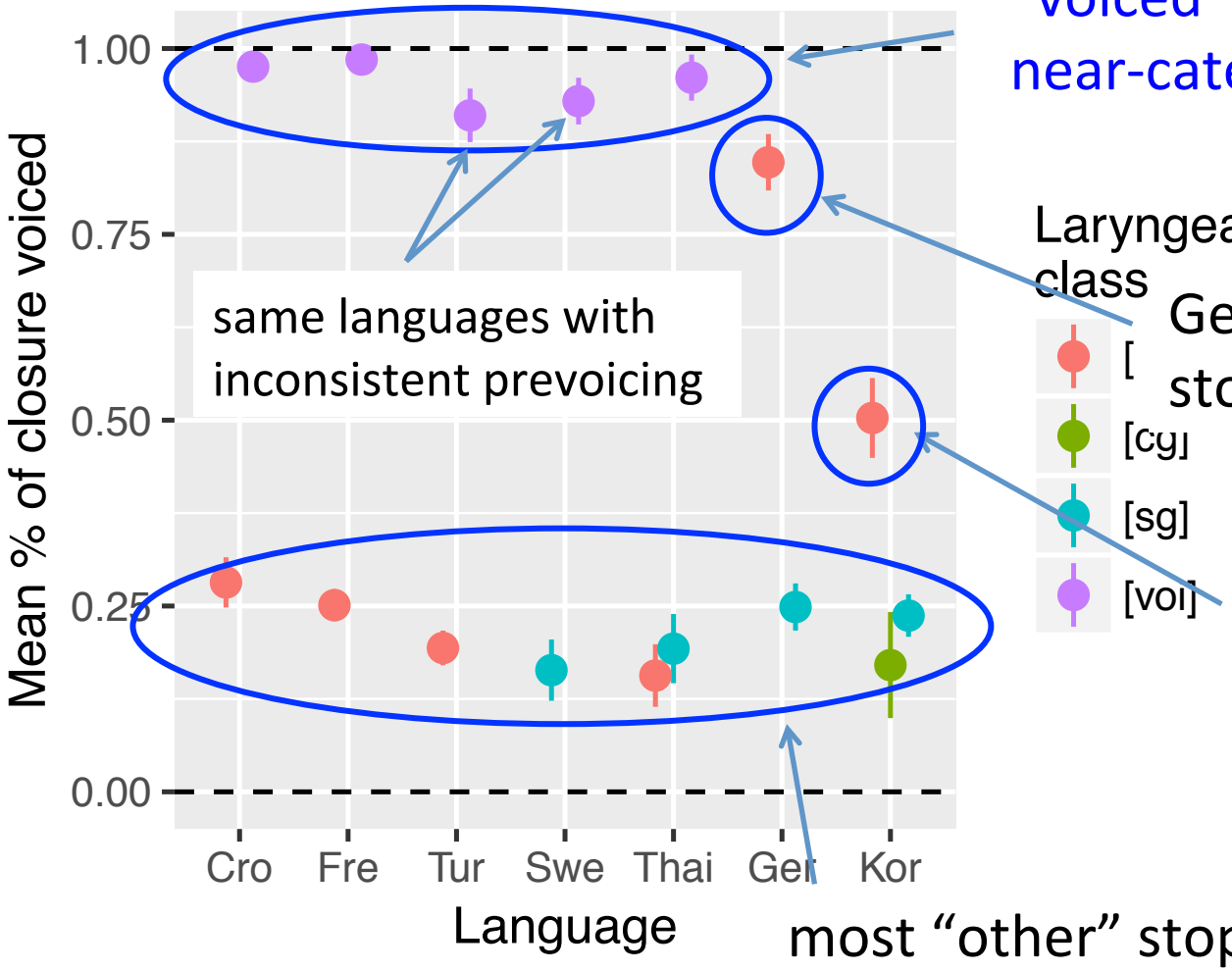
Expectations

"passive voicing" or none*

near-100% voicing

* Beckman et al. (2013): *no* passive voicing if e ∃ [voi] stops in language

Results: voicing during closure



"voiced" stops: near-categorical VDC

German lenis stops: ??

Korean "lax" stops: allophonically voiced (Jun ,1994)

most "other" stops: passive voicing (15-25%)

VCV position: Discussion

- Criterion 3: voicing during closure
  - ✔ (mostly)
- [voi] stops: near-full VDC
- non-[voi] stops
  - Mostly: low/inconsistent VDC
  - Exceptions:
    - Korean (due to phonology)
    - German
  - No evidence for distinction between languages with/without active [voi] (Beckman et al., 2013)

Summary of results

	Croatian	French	Turkish	Swedish	Thai	German	Korean
Prevoicing	✔?	✔	X	X	✔	✔	✔
Rate ~ VOT	✔	✔	✔	✔	✔	✔?	✔
Closure voicing	✔	✔	✔	✔	✔	✔?	✔?

- Q1: do criteria hold up across 7 languages?
- Q2: do criteria give convergent evidence `` ``?

Discussion

[voi], [+voice], [stiff], etc.

- ##C prevoicing: standardly used to diagnose "voiced" stops cross-linguistically (Lisker & Abramson, 1964; etc.)
  - in lab speech / isolated words

artefact of hyperarticulation?

- Our data:
  - ##C "Voiced" stops not consistently prevoiced in read sentences: Turkish, Swedish, Croatian
- Also:
  - Dutch, Am. English (van Alphen & Smits, 2004; Davidson, 2015)
  - Glasgow spontaneous speech (Stuart-Smith et al. 2015)

Discussion

- Speech rate, voicing during closure criteria
  - always work for [voi] stops
  - ⇒ better diagnostics than prevoicing
  - mostly work for [ ], [sg], [cg] stops

- SR, VDC criteria give largely convergent evidence across 7 languages
  - Assuming privative "laryngeal realism" features.
  - Supports phonetic realization/phonological features link made by LR, similar theories

    (e.g. Avery & Idsardi, 2001; Honeybone, 2005; Iverson & Salmons, 1995; Jessen, 1998)

Discussion

- Relationship between how languages realize laryngeal contrasts <u>across positions</u>
  - Novel
  - Could account for via features, or "controlled" phonetics (Solé, 2007)?
  - More data needed to test

- Future work:
  - Codas
  - More languages
  - More cues (e.g. F0)

Thanks

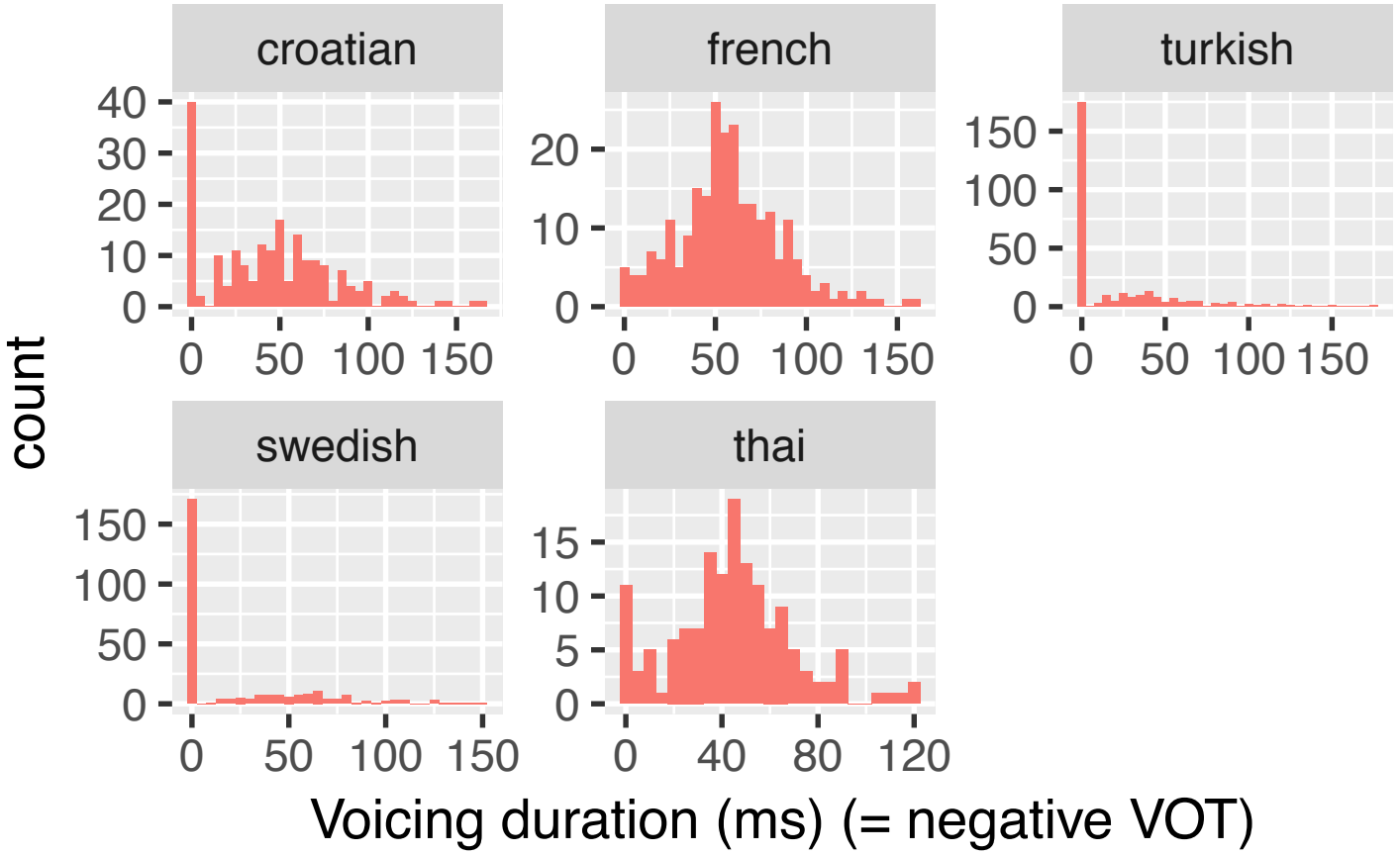
- Comments: Hye-Young Bang, Pat Keating, Heather Goad

- Funding:

Extra

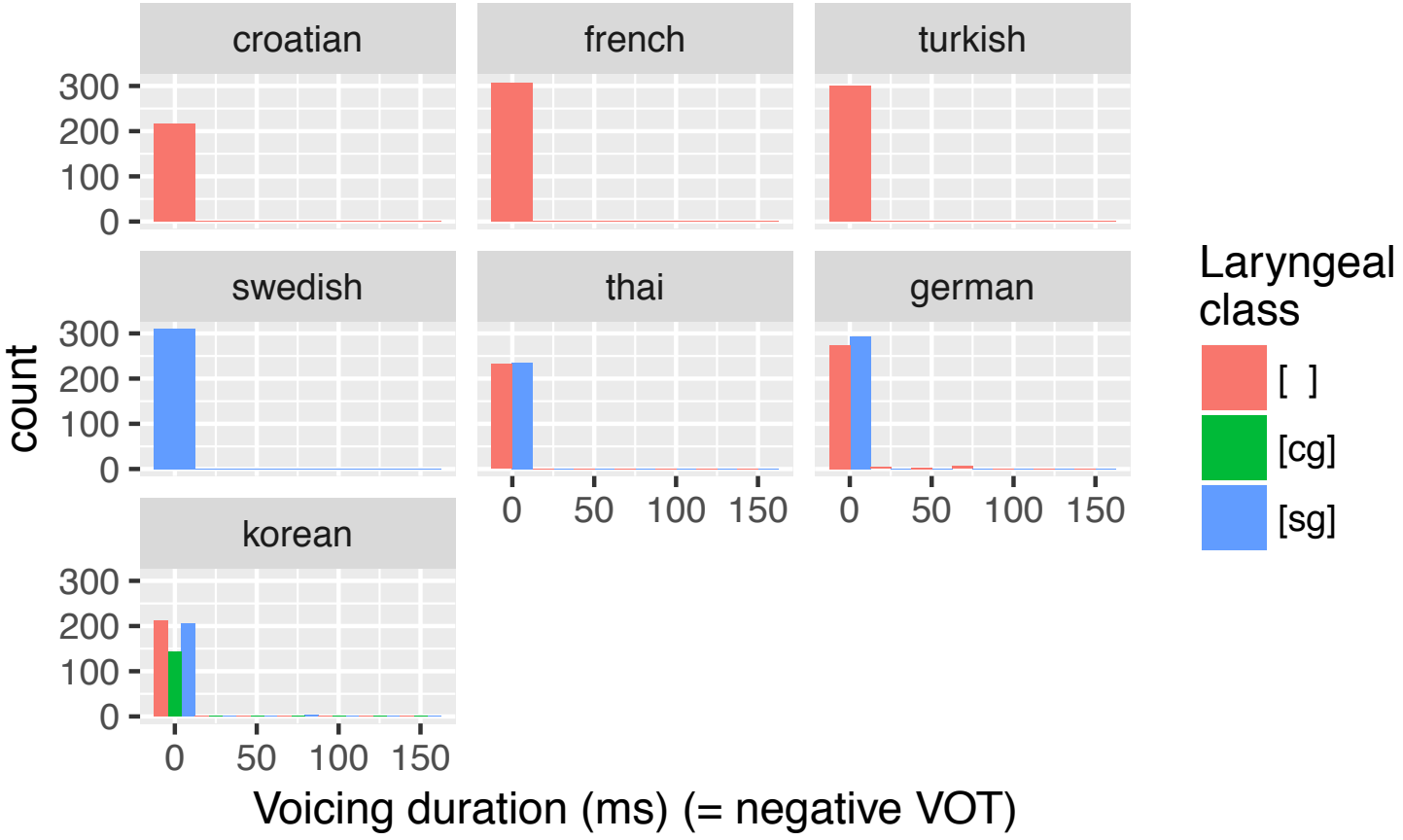
Negative VOT: "voiced" stops

- Amount of prevoicing for ##C [voi] stops :



Negative VOT: other stops

- Amount of prevoicing for ##C non-[voi] stops:



Swedish & Turkish examples