W6-1: Vowel devoicing

JAPN398D: The Sounds and Dialects of Japanese

10/2/2023

Today’s class

- What is vowel devoicing in Japanese?
- Vowel devoicing in Tokyo Japanese (Tsuchida 1997)
- Social factors (Amino et al. 2018)

Vowel devoicing

- High vowels /i, u/ get devoiced in the following two environments.

1. Between two voiceless consonants.
   - /i, u/ → [–voiced] / [C, –voiced] __ [C, –voiced]
   - e.g. くさ（草）‘grass’ /kusa/ → [kɯ̥sɑ]

2. Between a voiceless consonant and a pause (、 or 。).
   - /i, u/ → [–voiced] / [C, –voiced] __ #
   - e.g. です ‘COP’ /desu/ → [desɯ̥]

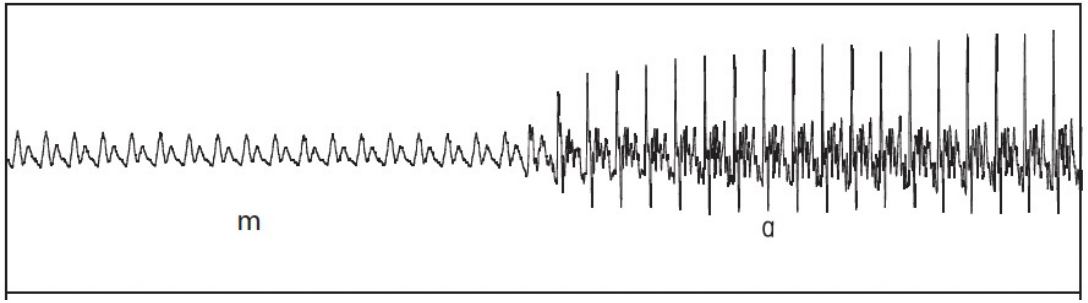
Japanese consonants (conservative)

	Bilabial		Alveolar		Palatal		Velar		Glottal	
Stop	p (ぱ)	b (ば)	t (た)	d (だ)			k (か)	g (が)		
Fricative			s (さ)	z (ざ)						h (は)
Nasal		m (ま)		n (な)						
Tap				r (ら)						
Approximant		w (わ)				y (や)				

- ぱ行　/p/: [p]
- た行　/t/: [t], [cɕ], [c]
- さ行　/s/: [s], [ɕ]
- か行　/k/: [k]
- は行　/h/: [h], [ç], [ɸ]

Waveforms

- Vowels have the highest relative amplitude and periodic waves.

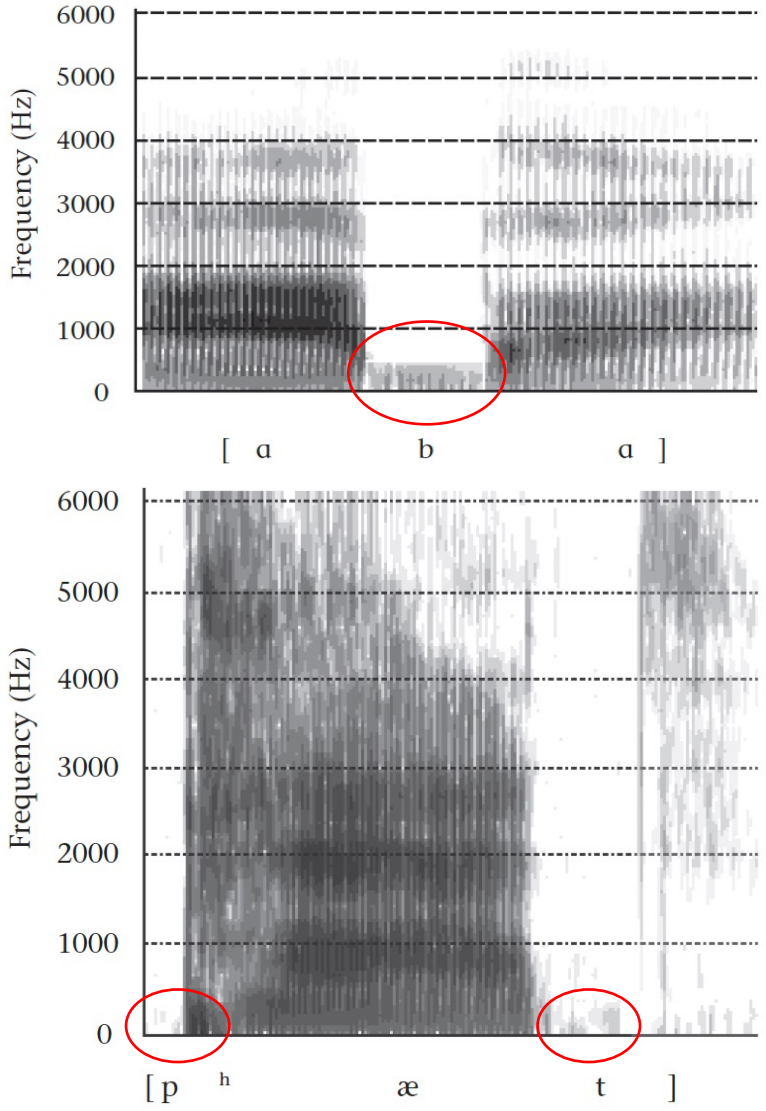


Zsiga (2013): Figure 7.8

Spectrograms

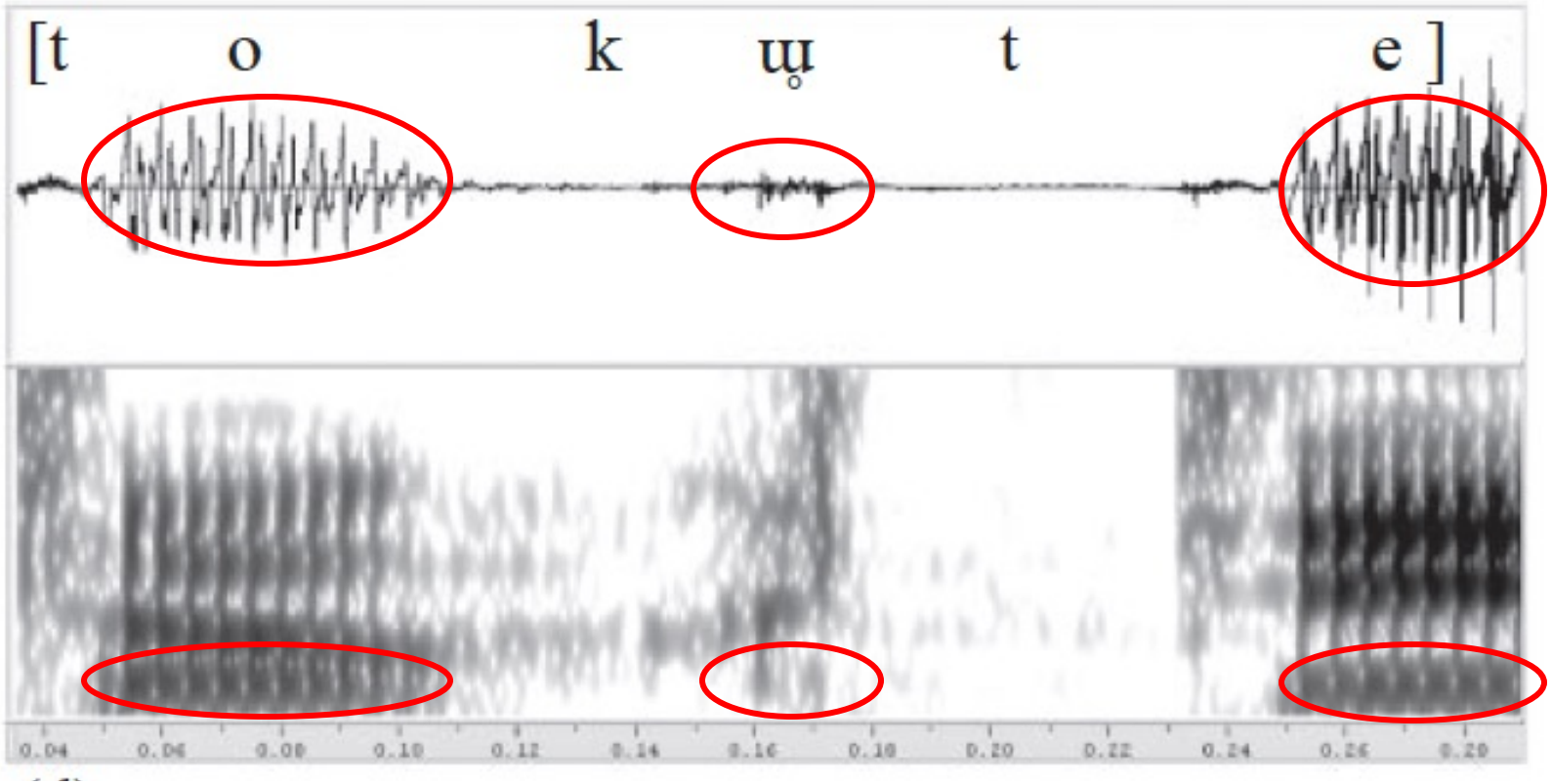
- A dark bar at the bottom of a spectrogram tells us that the sound is voiced.

- This dark bar is called a voice bar.



Language Files, p. 82

Waveforms and spectrograms



Vowel devoicing

- Is it vowel “deletion”, rather than vowel “devoicing”?
  - /i, u/ → Ø / [C, –voiced] __ [C, –voiced]
  - /i, u/ → Ø / [C, –voiced] __ #

- It is NOT vowel deletion!
  - てきかく（的確）‘accurate’ /tekikaku/ → [tekɨ̥kakɯ]
  - せっかく（折角）‘long-waited’ /seQkaku/ → [sekːːakɯ]
  - [kɨ̥k] and [kːː] show different waveforms and spectrograms.

Tsuchida (1997)

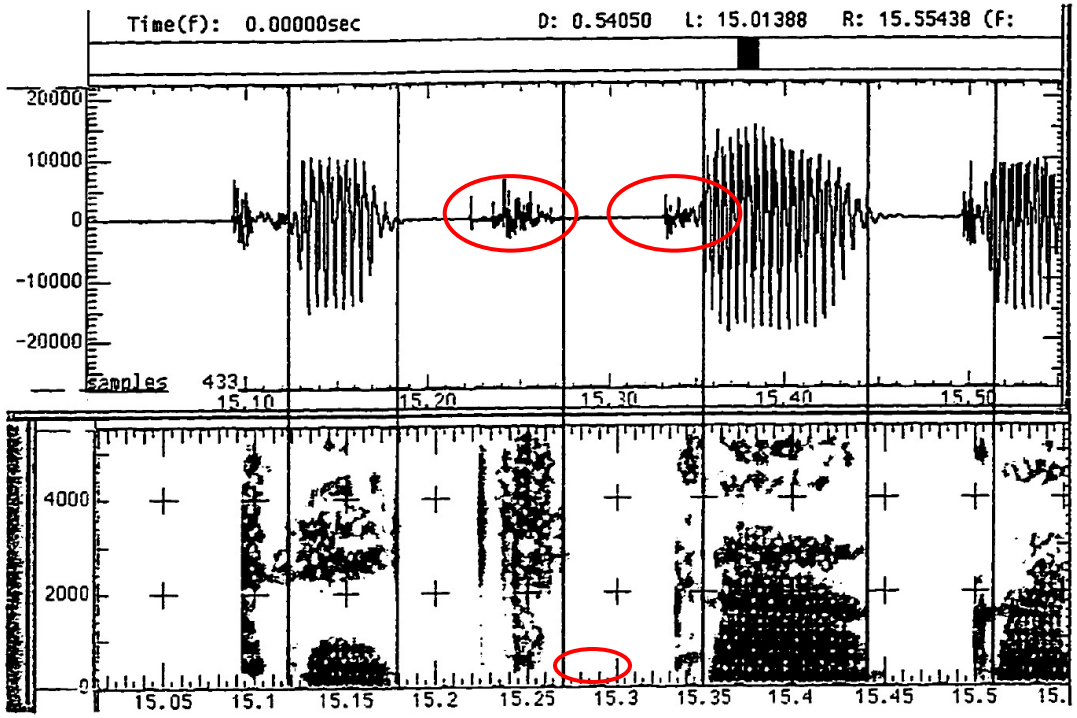


Figure 3.3 Waveform and spectrogram of [tekịkaku] 'accurate'

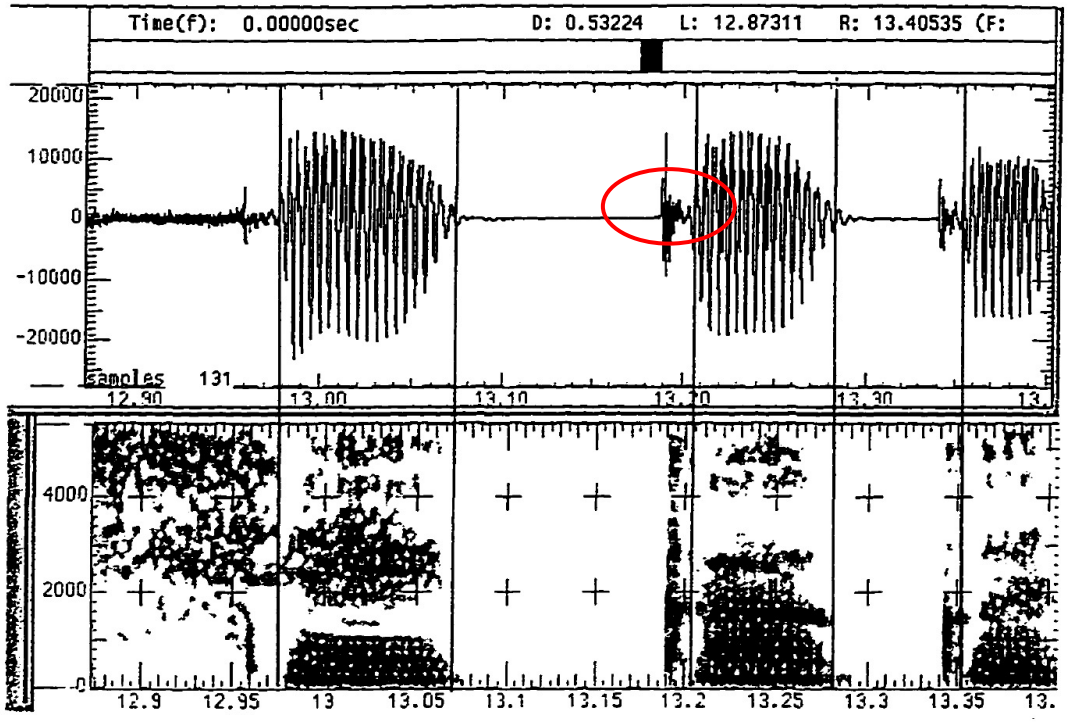


Figure 3.4 Waveform and spectrogram of [sekkaku] 'long-awaited'

Vowel devoicing

- Is it vowel “deletion”, rather than vowel “devoicing”?
  - /i, u/ → Ø / [C, –voiced] __ [C, –voiced]
  - /i, u/ → Ø / [C, –voiced] __ #

- It is NOT vowel deletion!
  - きしょう（気象）‘weather’ /kišoH/ → [kʲi̥ɕoː] (narrow)
  - くしょう（苦笑）‘bitter smile’ /kušoH/ → [kʷɯ̥ɕoː] (narrow)

- Coarticulation: [kʲ] vs. [kʷ]
  - They cannot be phonemes because it is against native-speaker intuitions.

Vowel devoicing

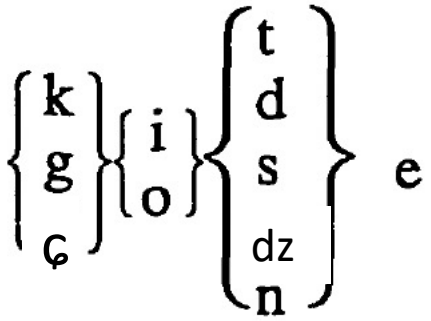
- Does vowel devoicing always occur in the two environments?
  - → No
  - Vowel devoicing is gradient (not 100%).
  - Some factors completely block vowel devoicing.

- We will see these factors.
  1. Voiceless fricatives and vowel devoicing
  2. /h/ and vowel devoicing
  3. Consecutive devoicing
  4. Pitch accent and vowel devoicing
  5. Social factors (dialectal variation)

(1) Voiceless fricatives

- Experiment 1 in Tsuchida (1997)
  - Tsuchida recorded one male Tokyo Japanese speaker.

- Stimuli: CVCV words, including nonce words



- Carrier phrase: いいXらしい。

(1) Voiceless fricatives

1. Stop-Stop
   - [kite], [kide], [gite], [gide], [kote], [kode], [gote], [gode]
2. Stop-Fricative
   - [kise], [kize], [gise], [gidze], [kose], [kodze], [gose], [godze]
3. Fricative-Stop
   - [ɕite], [ɕide], [ɕote], [ɕode]
4. Fricative-Fricative
   - [ɕise], [ɕidze], [ɕose], [ɕodze]
5. Stop-Nasal
   - [kine], [gine], [kone], [gone]
6. Fricative-Nasal
   - [ɕine], [ɕone]

(1) Voiceless fricatives

Table 4.1 Percentage of tokens that were devoiced in unaccented words

[i] next to a voiced C [o] in all environments	[i] between two voiceless C's	
[kide], [ʃide], [kote], etc.	[kite], [kise], [ʃite]	[ʃise]
0%	100%	23%

- Non-devoicing environments: 0%
- Devoicing environments:
  - Stop-Stop, Stop-Fricative, Fricative-Stop: 100%
  - Fricative-Fricative: 23%
- Vowel devoicing is less likely to occur between two voiceless fricatives.

(1) Voiceless fricatives

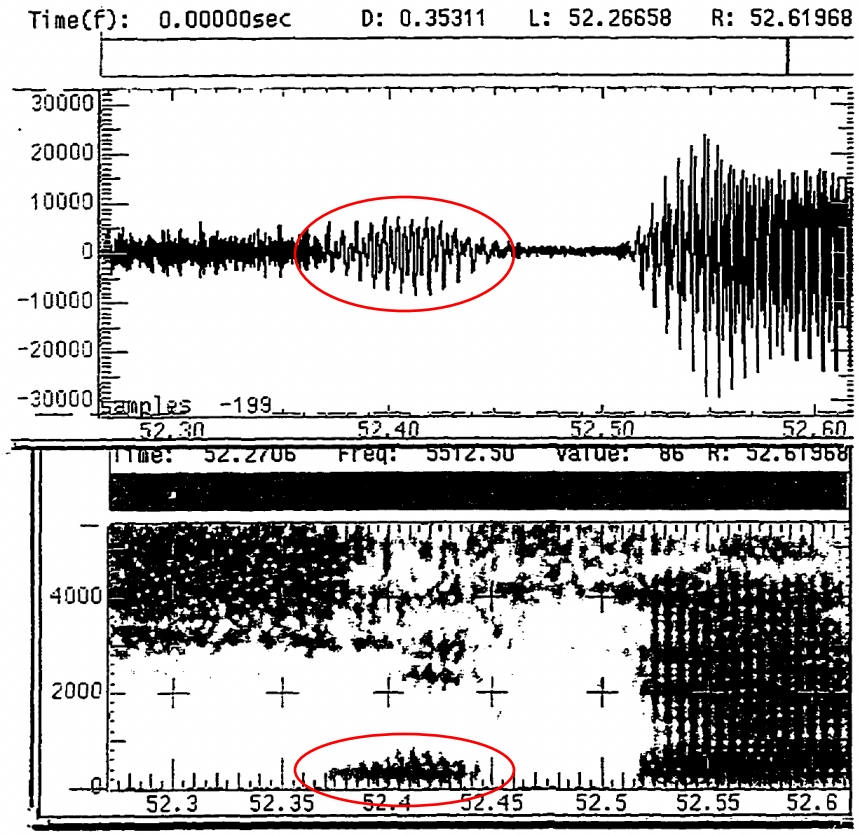


Figure 4.13a Waveform and spectrogram of [ʃise] with a voiced vowel

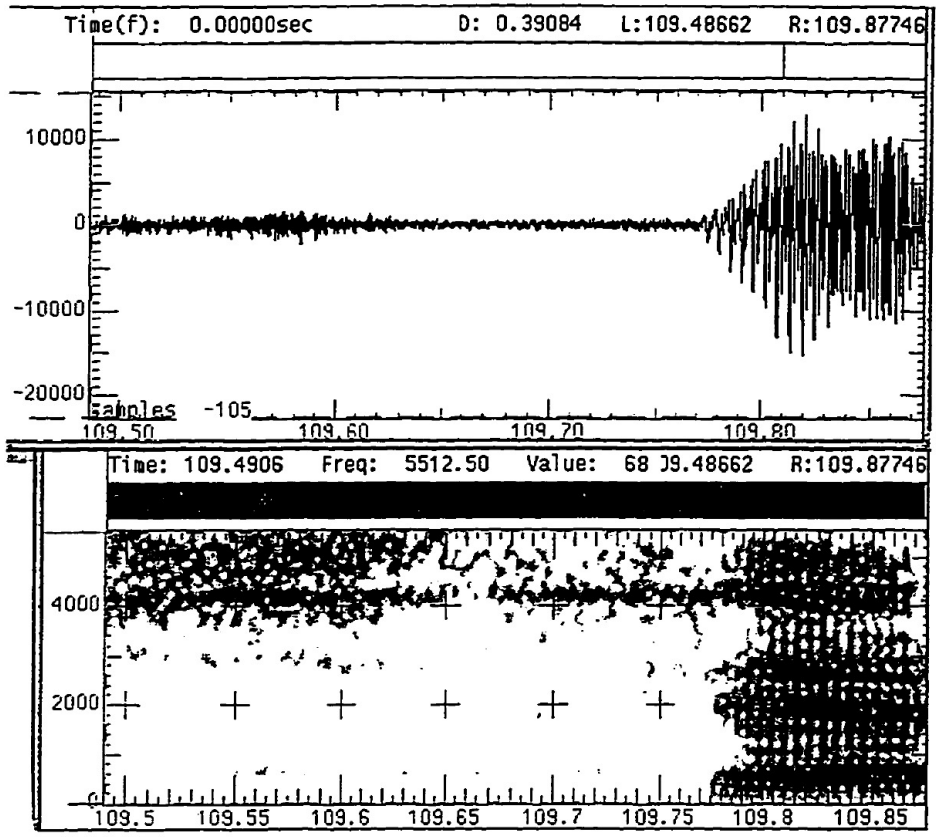


Figure 4.13b Waveform and spectrogram of [ʃi̥se] with a devoiced vowel

(2) /h/ ([h, ç, ɸ])

- Experiment 2 in Tsuchida (1997)
  - Tsuchida recorded the same male Tokyo speaker.

- Stimuli: C_1VC_2V words, where C_2 is [h, ç, ɸ].

$$\begin{Bmatrix} k \\ g \end{Bmatrix} \begin{Bmatrix} i \\ o \end{Bmatrix} \begin{Bmatrix} \Phi & u \\ h & e \\ ç & i \end{Bmatrix}$$

- Carrier phrase: いいXらしい。

(2) /h/ ([h, ç, ɸ])

- [kiɸɯ], [kiçi], [kihe]
- [koɸɯ], [koçi], [kohe]

- [giɸɯ], [giçi], [gihe]
- [goɸɯ], [goçi], [gohe]

(2) /h/ ([h, ç, ɸ])

Table 5.2 Devoicing rates of vowels followed by allophones of /h/ in accented words

	kíɸu	kíhe	kíçi	[í]'s adjacent to [g] all [ó]'s
dv rates	0%	0%	0%	0%

- Vowel devoicing never happens when /i/ is followed by an allophone of /h/.

(2) /h/ ([h, ç, ɸ])

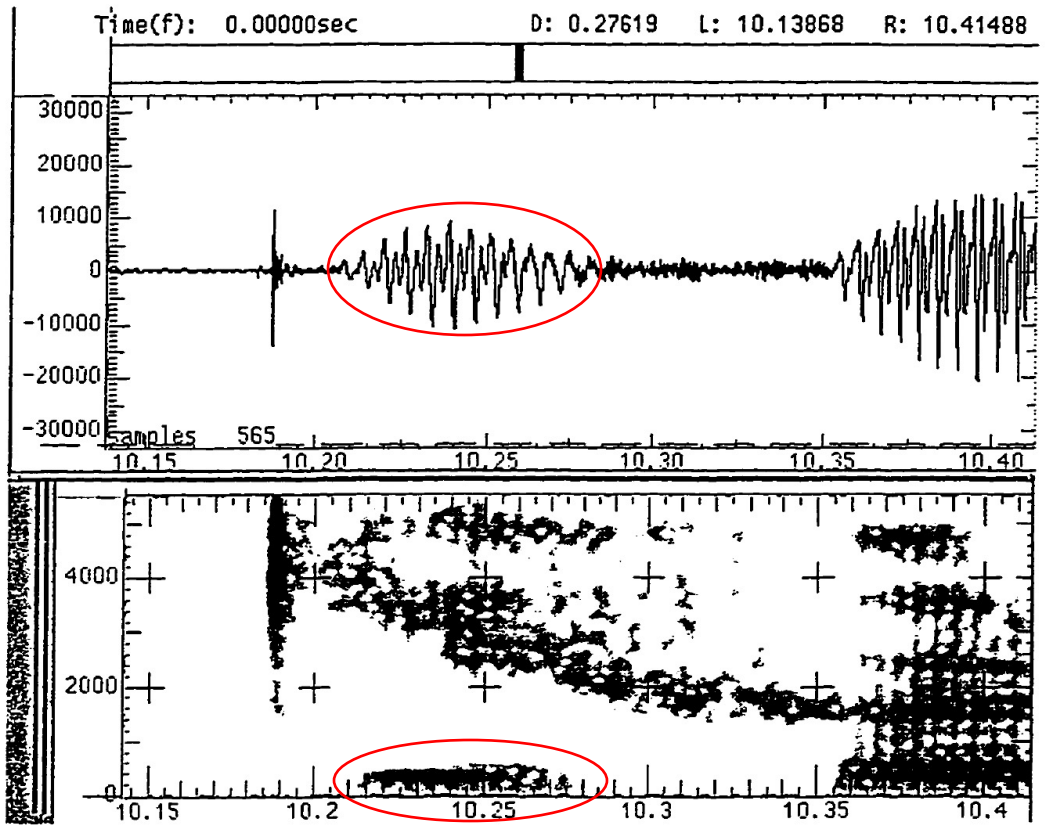


Figure 5.2 Waveform and spectrogram of [kiɸu]

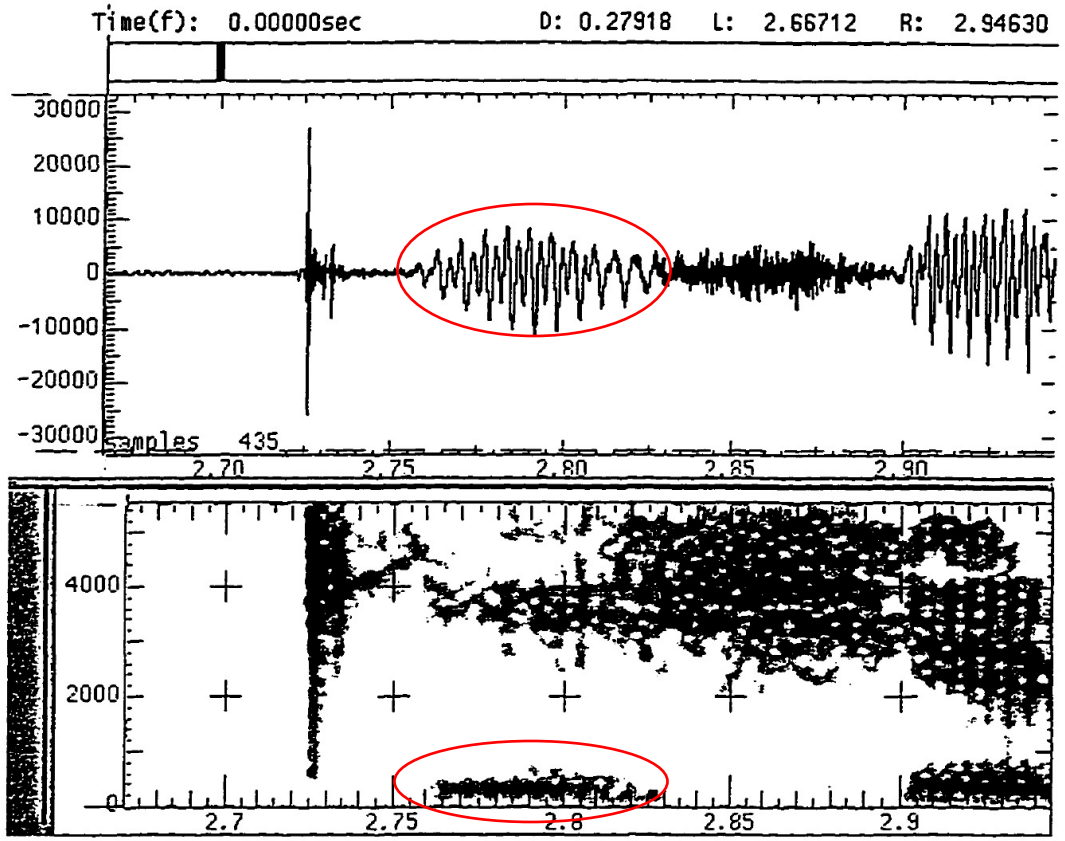


Figure 5.4 Waveform and spectrogram of [kiçi]

(3) Consecutive devoicing

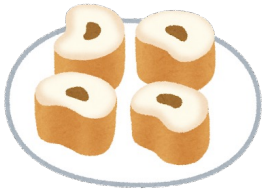
- Experiment 3 in Tsuchida (1997)
  - Tsuchida recorded the same male Tokyo speaker.

- [C, −voiced] /i, u/ [C, −voiced] /i, u/ [C, −voiced]
  - Do both vowels get devoiced?

- Carrier phrase: いいXらしい。

(3) Consecutive devoicing

- Stimuli (Unaccented: LH…H)



• [ɸɯ]	ふ（麸）	‘wheat-gluten bread’
• [ɸɯkɯ]	ふく （福）	‘good fortune’
• [ɸɯkɯɕi]	ふくし（副詞）	‘adverb’
• [ɸɯkɯɕiki]	ふくしき（複式）	‘double’
• [ɸɯkɯɕikika]	ふくしきか（複式化）	‘make it double’

(3) Consecutive devoicing

- [ɸɯ] ふ
- [ɸɯkɯ] ふく
- [ɸɯkɯɕi] ふくし
- [ɸɯkɯɕiki] ふくしき
- [ɸɯkɯɕikika] ふくしきか

- Alternating vowels are devoiced.
- Red: Devoiced
- Blue: Not devoiced

(3) Consecutive devoicing

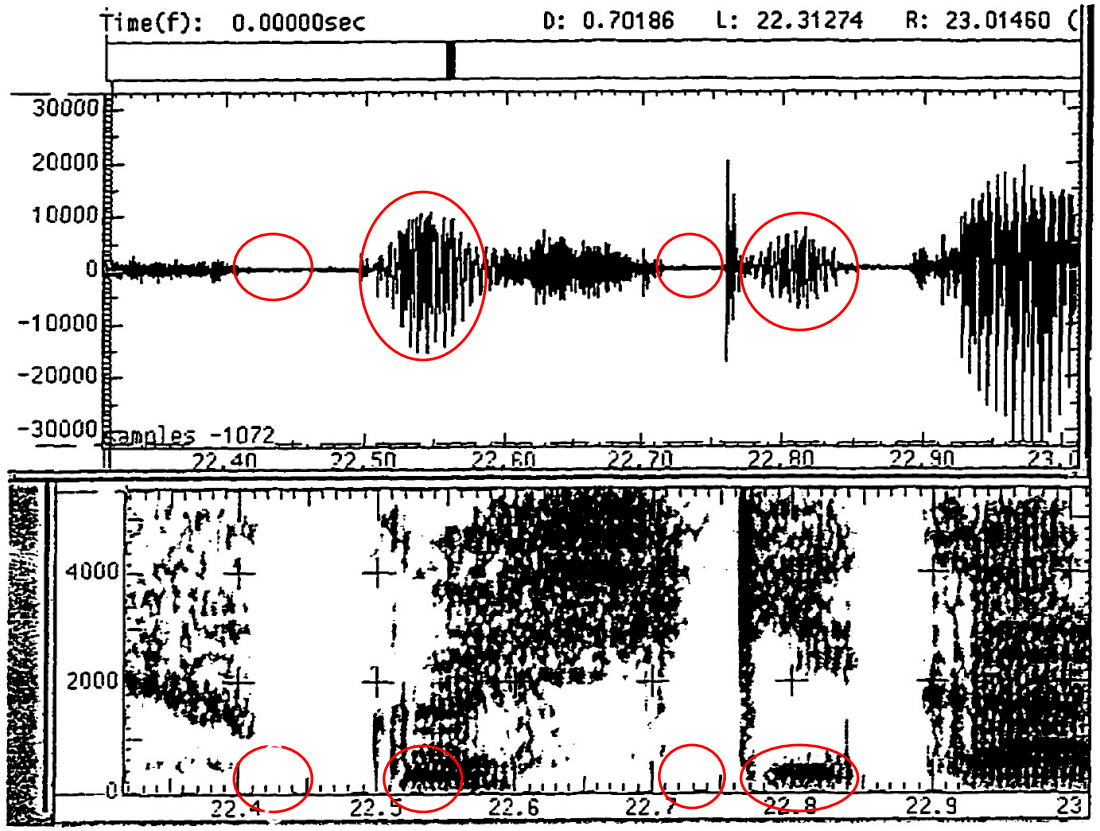


Figure 6.5 Waveform and spectrogram of [ɸu̥ku͡ʃi̥ki̥ka]

Summary of Tsuchida (1997)

1. Vowel devoicing is less likely to occur when /i/ and /u/ are between two voiceless fricatives.
2. Vowel devoicing does not occur when /i/ and /u/ occur between a voiceless consonant and an allophone of /h/ in conservative phonology (= [h, ç, ɸ]).
3. Consecutive vowel devoicing environments show an alternating devoicing pattern.

(4) Pitch accent

- “Vowel devoicing interacts with accent, although to a much smaller extent nowadays than in the past.” (Vance 2008: p. 211)

- 「〇〇子」→ Initial-accented (red → devoiced)
  - たか子 → /tákako/ (HLL)
  - ふさ子 → /fúsako/ (HLL) or /fusáko/ (LHL; accent shift, but marginal)
  - きく子 → /kíkuko/ (HLL; alternating pattern)
    - きっこ /kiQko/; nickname

(5) Social factors

- Amino et al. (2018) examine social factors that affect vowel devoicing.

- Gray: Vowel devoicing occurs frequently (e.g. Tokyo).
- Dark gray: Vowel devoicing occurs infrequently (e.g. Osaka).

Amino et al. (2018): Figure 1
Reprinted from NHK日本語発音アクセント辞典

Vocalic vs. Consonantal

Osaka Japanese

Baba Nobuyuki; Leader of the Japan Innovation Party

https://www.youtube.com/watch?v=i2AiypztgzY

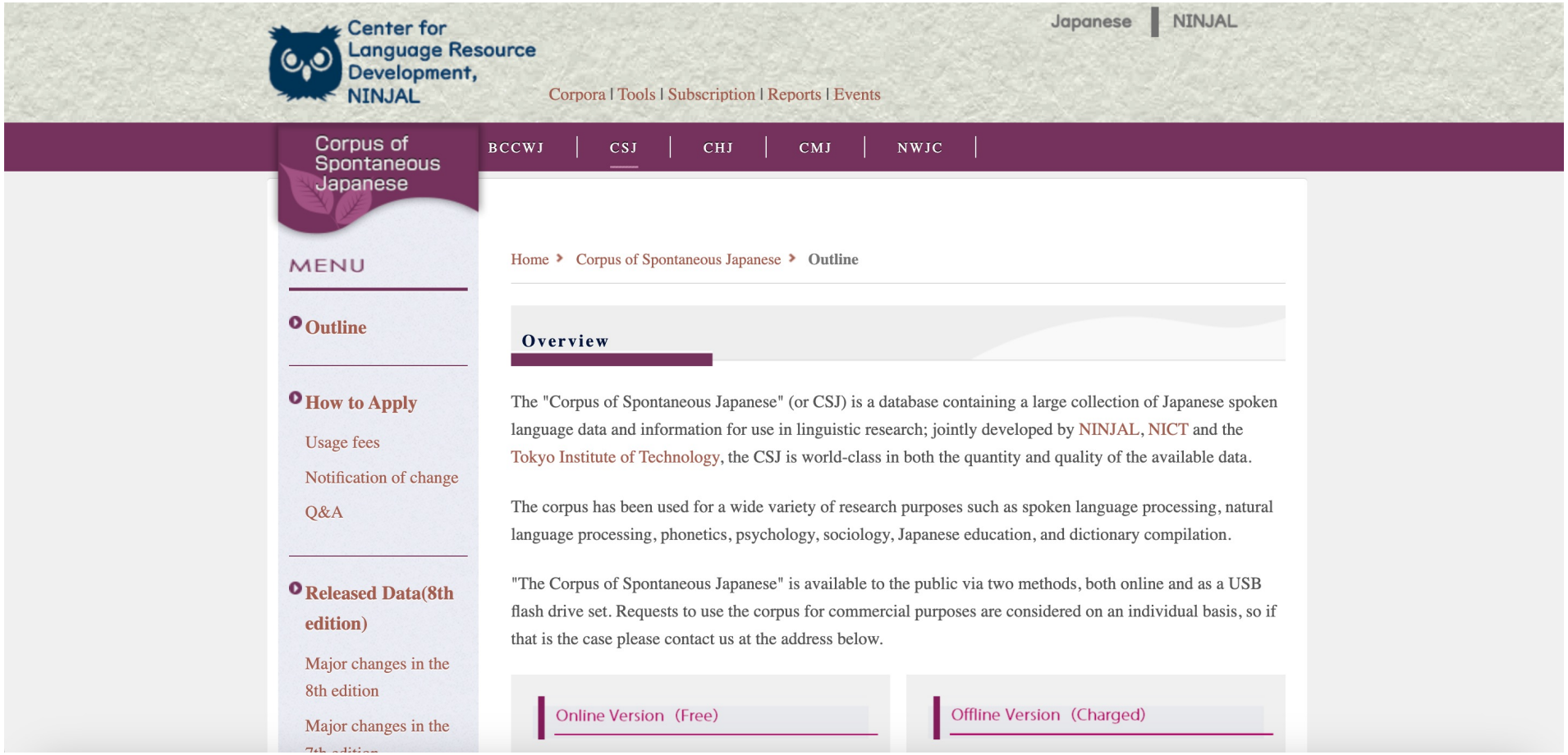
- みんなで考えていく必要があると思いますす。
- 正確な答えになると思いますす。
- 一度リセットをさせていただくく。

(5) Social factors

- In this study, Amino et al. analyzed data from the Corpus of Spontaneous Japanese (CSJ).
  - Academic Presentation Speech
  - Simulated Public Speaking

- 日本語話し言葉コーパス（https://clrd.ninjal.ac.jp/csj/index.html）
  - This corpus was developed by the National Institute for Japanese Language and Linguistics (NINJAL), the National Institute of Information and Communications Technology (NICT), and Tokyo Institute of Technology.
  - Fee: ¥250,000 (= $2,500 if $1 = ¥100)

日本語話し言葉コーパス



日本語話し言葉コーパス

https://clrd.ninjal.ac.jp/csj/en/sample.html

Academic Presentation Speech

え、パラ言語情報ということなんですが、簡単に最初に、えー、復習をしておきたいと思います。ま、あの、こうやって、話しておりますと、それはもちろんあの言語的情報を伝えるということが１つの重要な目的なんでありますが、同時にパラ言語情報…

Simulated Public Speaking

それから最後に、えー、司法判断、裁判の結果ですね。それに対する不信というものも感じた記憶があります。それはどういうことかっていうと、まあ先程一言いましたように、その、先生方、対応された先生方は、１人ぐらい例外があったような気がしますけども、みんな…

(5) Social factors

- Amino et al. analyzed data from 226 speakers (F: 63, M: 163).
  - 22.2 target vowels per speaker

- D_F: Dialects with frequent vowel devoicing
- D_{IF}: Dialects with infrequent vowel devoicing

Table 1 Classification of speakers into groups. D_F and D_{IF} stand for the dialects where vowel devoicing occurs frequently and infrequently, respectively.

Group	Dialect		Population
	Speaker	Parents	
1	D_F	Both D_F	60
2		One D_F, one D_{IF}	55
3		Both D_{IF}	19
4	D_{IF}	Both D_{IF}	66
5		One D_F, one D_{IF}	21
6		Both D_F	5

I would belong to Group 4!

(5) Social factors

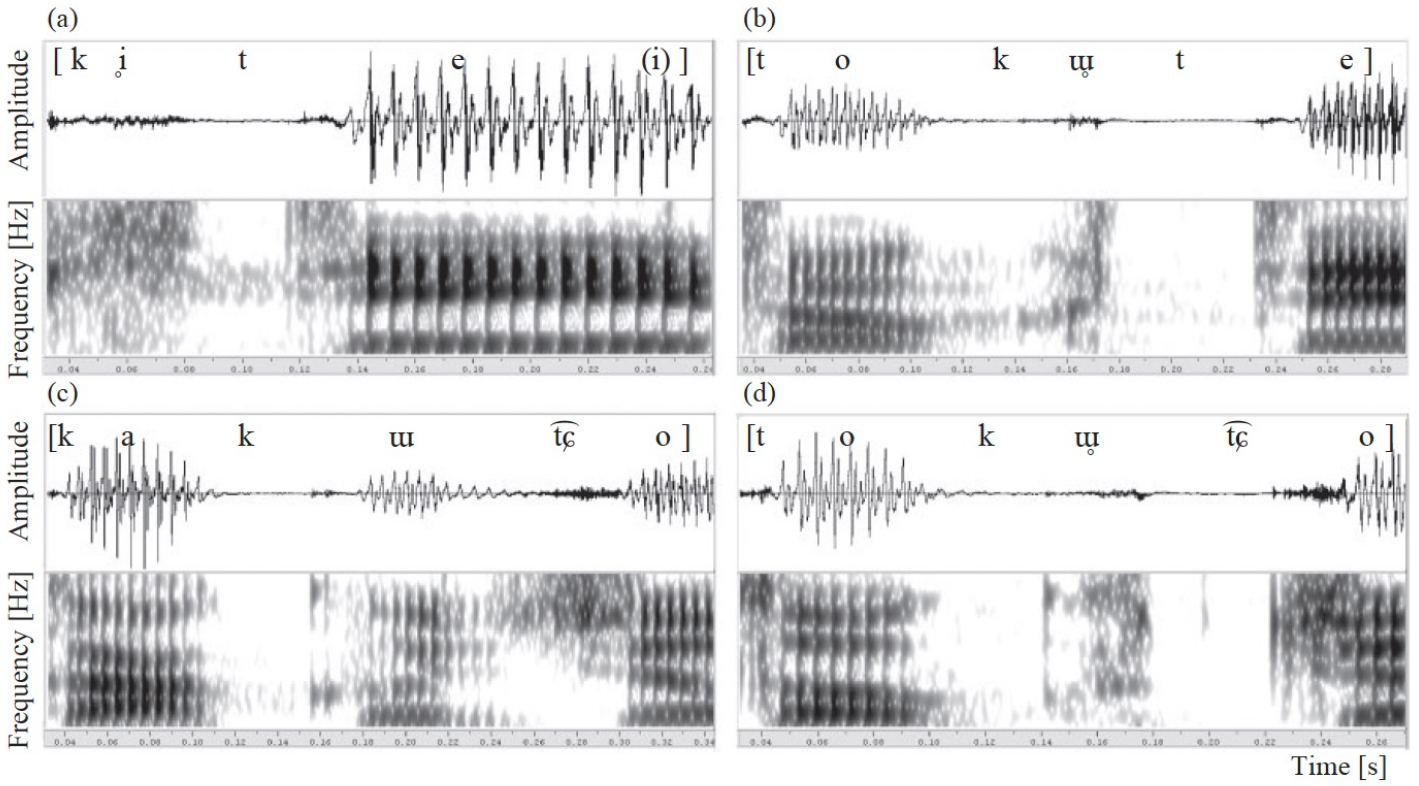


Fig. 2 Examples of the analysis: (a) /k̥ite(ɪrɯ)/ (coming), (b) /tokɯ̥te(ː)/ (specific), (c) /kakɯt͡ɕo(ː)/ (extension), (d) /tokɯ̥t͡ɕo(ː)/ (characteristics). Only (c) was judged as 'voiced.'

(5) Social factors

Table 1 Classification of speakers into groups. D_F and D_{IF} stand for the dialects where vowel devoicing occurs frequently and infrequently, respectively.

Group	Dialect		Population
	Speaker	Parents	
1	D_F	Both D_F	60
2		One D_F, one D_{IF}	55
3		Both D_{IF}	19
4	D_{IF}	Both D_{IF}	66
5		One D_F, one D_{IF}	21
6		Both D_F	5

Results

Table 3 Average percentage of vowel devoicing (P_{VD}) with standard deviation (*S.D.*) for each speaker group.

Speaker groups	Average percent devoiced (*S.D.*)
1	96.3 (6.32)
2	92.7 (9.50)
3	89.4 (10.34)
4	70.7 (19.02)
5	87.2 (13.09)
6	84.8 (17.46)

(5) Social factors

- D_F speakers (Groups 1-3) speakers show more devoicing than D_{IF} speakers (Groups 1-4).

- Parents' dialects affect the percentage of vowel devoicing.
  - 1: Both D_F → 96.3%
  - 3: Both D_{IF} → 89.4%
  - 4: Both D_{IF} → 70.7%
  - 6: Both D_F → 84.8%

Results

Table 3 Average percentage of vowel devoicing (P_{VD}) with standard deviation (*S.D.*) for each speaker group.

Speaker groups	Average percent devoiced (*S.D.*)
1	96.3 (6.32)
2	92.7 (9.50)
3	89.4 (10.34)
4	70.7 (19.02)
5	87.2 (13.09)
6	84.8 (17.46)

Experiments vs. Corpora

Experiments (e.g. Tsuchida 1997)

- Pros
  - Controlled stimuli
  - Understudied languages/varieties
- Cons
  - Non-spontaneous speech
  - Not enough amount of data

Corpora (e.g. Amino et al. 2018)

- Pros
  - Spontaneous speech
  - Enough amount of data
- Cons
  - Uncontrolled stimuli
  - Only well-studied languages/varieties

Summary

1. Vowel devoicing is less likely to occur when /i/ and /u/ are between two voiceless fricatives.
2. Vowel devoicing does not occur when /i/ and /u/ occur between a voiceless consonant and an allophone of /h/ in conservative phonology (= [h, ç, ɸ]).
3. Consecutive vowel devoicing environments show an alternating devoicing pattern.
4. Pitch accent and social factors affect vowel devoicing.

北海道の昆布に被害（9/26）

北海道函館市は、高級な昆布の1つ「真昆布」が有名です。しかし、夏にとった真昆布にヒドロゾアというクラゲなどの仲間が付いていて、漁業をしている人たちが困っています。

市によると、この昆布を食べても体に問題はありません。しかし、売るときにきれいに見えないため、付いたところを切って捨てます。このため、売ることができる昆布が少なくなったり、市場などに出すのが遅くなったりしています。

真昆布を海で50年以上育てている人は「こんなにひどい被害は初めてです。毎年続いたら、仕事ができなくなります」と話しています。

函館市は、今年の夏はとても暑くて、海の水の温度が高かったことが原因だろうと考えています。そして、漁業をしている人の団体にもっと話を聞くことにしています。

https://www3.nhk.or.jp/news/easy/k10014206431000/k10014206431000.html

北海道の昆布に被害（9/26）

- 聞くことに…
- [kikɯkotoni]

- Which vowel is devoiced?

- 聞く （unaccented; LH）
- [kɨkɯkotoni]

References

- Amino, Kanae, Hisanori Makinae, Toshiaki Kamada, and Takashi Osanai. 2018. Reference data on Japanese vowel devoicing: Effects of speakers' and parents' places of origin and within-speaker reproducibility. *Acoustic Science & Technology* 39(3), 207-214. DOI: https://doi.org/10.1250/ast.39.207
- Tsuchida, Ayako. 1997. Phonetics and phonology of Japanese vowel devoicing. Cornell University dissertation.