

# 日中韓辭典研究所

## The Role of Phonetics and Phonetic Databases in Japanese Speech Technology

日本語音声技術に於ける音韻論及び音声学の役割

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# Introduction

- Kana syllabary is not really phonemic
- kana-to-phoneme mappings not unique
- Speech technology developers use kana pronunciation dictionaries
- Convert phonemes into phones by generating correct allophonic variants

# Summary

- Japanese has complex allophonic patterns, e.g.
  - vowel devoicing (福生 フッサ [ɸɯ̥s̥sa])
  - Nasalization (鏡 カガミ [kaŋami])
  - affricate spirantization (恥 ハジ [hazi (ha<sup>d</sup>ʑi)])
- These phonetic features must be considered when implementing:
  - Automatic Speech Recognition
  - allophone generation for pronunciation dictionaries
  - phonetic transcription systems like kana-to-IPA
- For first time, JPD provides both IPA transcriptions and accent codes

# Japanese Vowels

Kana	Phonemic	Broad	Narrow
ア	a	a	ä
イ	i	i	i
ウ	u	ʊ	ɯ̥ ~ ɯ̜
エ	e	e	e̞
オ	o	o	o̞

# Nasalization Variants

Orthographic	Kana	Phonetic	Remarks
影	カゲ	[kage]	unnasalized by most speakers
影	カゲ	[kaŋe]	nasalized intervocalically
影	カゲ	[kaye]	fricativized in fast speech
画像	ガゾウ	[gazo:]	never nasalized word initially

# Nasal Assimilation

Orthographic	Kana	Phonetic
自分	ジブン	dʒibɯɴ
純子	ジュンコ	dʒɯɴko
慎一	シンイチ	ɕiĩtɕi
新聞	シンブン	ɕimbɯɴ
運動	ウンドウ	undo:
蒟蒻	コンニャク	koɴɲaku
本	ホン	hoɴ, hõ

# Spirantized Affricates

Orthographic	Phonemic	Phonetic
自分	/zibun/	[dzibuɯN (ʃzibuɯN)]
恥	/hazi/	[hazi (ha <sup>d</sup> ʒi)]
地震	/zisin/	[dziin (ʃziçin)]
塩	/sio/	[çio (sio)]

# Sequential Voicing

Orthographi c	Voiceless	Voiced
いなり寿司	[inari] + [suɕi]	[inarizɯɕi]
物語	[mono] + [katari]	[monogatari]
二人連れ	[futari] + [tsure]	[futarizure]
棒立ち	[bo:] + [tatɕi]	[bo:datɕi]
花火	[hana] + [hi]	[hanabi]

# Palatalized Consonants

Orthographic	Phonemic	Phonetic
客	/kyaku/	[kʲaku]
日本	/niQpon/	[nʲipʷpon]
民	/tami/	[tamʲi]
滝	/taki/	[takʲi]

# Geminated Consonants

Orthographic	Phonemic	Phonetic
日本	/niQpon/	[n <sup>h</sup> ip <sup>h</sup> poN]
八歳	/haQsai/	[hassai]
発注	/haQtuu/	[hat <sup>h</sup> tɕu:]
発車	/haQsja/	[haçça]

# Glottalized Vowels

Orthographic	Phonemic	Phonetic
アッ	/aQ/	[aʔ̚]
鶯	/u/	[ʔ̚ɯʔ̚]
サッ	[saQ]	[saʔ̚]

# Accent Codes

Orthographic	Kana	Phonetic	Accent	Pitch Pattern	Remarks
井川	イカワ	[ikawa]	1	HLL(L)	first mora accented
井田	イダ	[ida]	0	LH(H)	accentless
磯貝	イソガイ	[isoŋai]	2	LHLL(L)	second mora accented
鏡	カガミ	[kaŋami]	3	LHH(L)	last mora accented
形	カタチ	[katatɕi]	0	LHH(H)	accentless

# Practical Applications of JPD

- Text-to-speech (TTS)
- Automatic speech recognition (ASR)
- Pedagogical research and CAL
- R&D of Japanese speech technology
- Phonetic transcription systems

# Compilation Methodology

- Analysis of allophonic variation and accent patterns
- Development of kana-to-IPA generator
- Database of ambiguous G2P mappings (トウ)
- Accent code generation
- Human proofreading

# Features of JPD

- 150,000-entry database
  - 100,000 general vocabulary
  - 50,000 personal names
- Developed in collaboration with 国研
- IPA transcriptions and accents for first time
- Compiled by editors trained in Japanese phonology

# JPD Sample Data

Headword	POS	Accent	Reading	Phonetic	Remarks
鏡	NC	3	カガミ	[kaɰami]	voiced velar nasal
鏡	NC	3	カガミ	[kagami]	voiced velar stop
鏡	NC	3	カガミ	[kaɰami]	voiced velar fricative
自分	NC	0	ジブン	[dʒibʷɴ]	weakening of voiced alveolopalatal plosive (fricativized)
続く	V5	0	ツヅク	[tsʷzʷkʷ]	devoicing of [tsʷ]
続く	V5	0	ツヅク	[tsʷzʷkʷ]	no devoiced vowel
恥	NC	2	ハジ	[haz̥i]	voiced alveolopalatal fricative
恥	NC	2	ハジ	[ha <sup>d</sup> ʒi]	voiced alveolopalatal affricate
本	NC	1	ホン	[hɔ̃ɴ]	uvular nasalized consonant
本	NC	1	ホン	[hõ]	close front nasalized vowel
井上	NP	0	イノウエ	[inow̥e]	ノウ is pronounced [now], not as with a long vowel [no:]
福生	NP	0	フッサ	[ɸʷs̥'sa]	first [s] is unreleased, devoicing of [ɸʷ]

# Future Work

- Primary goal: continue to advance CJK speech technology.
- Speech technology systems must have access to phonetic/phonological databases.
- Ongoing R&D of databases with phonetic transcriptions of actual speech.
- Future projects: expansion of JPD and compiling IPA databases for Chinese, Korean and Arabic.

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