INTER-LEARNER SHADOWING WITH SPEECH TECHNOLOGIES ENABLES AUTOMATIC AND OBJECTIVE MEASUREMENT OF COMPREHENSIBILITY OF LEARNERS' UTTERANCES

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RESEARCH QUESTION AND RELATED WORKS

Two different goals of pronunciation training
- Native-like vs. intelligible/comprehensible enough pronunciations
- Intelligibility and comprehensibility [Derwing+'09]
  - I: How many words are correctly identified in given L2 utterances?
    ➡ Focuses on results of listeners' process of understanding ➡ **offline**
  - C: How easily or smoothly given L2 utterances are understood?
    ➡ Focuses on how the understanding process is running while listening ➡ **online**

How to calculate intelligibility/comprehensibility of L2 speech?
- **Subjective** assessment
  - "How many words do you think you identified correctly?"
    100%, 80%, 60%, 50%,,,,,
  - "How easily did you understand the message?"
    Very easily, easily, rather easily,,,,,
- **Objective** assessment
  - L2 utterances were transcribed by native speakers **after** hearing them.
    Objective intelligibility = word-level correct transcription rate [Bernstein'03]
  - Listeners' behaviors are observed using physiological sensors.
    Listening effort observed using EEG (Electroencephalogram) [Song+'18]
    Cognitive load observed as the size of pupils using an eye-tracker [Govender+'18]
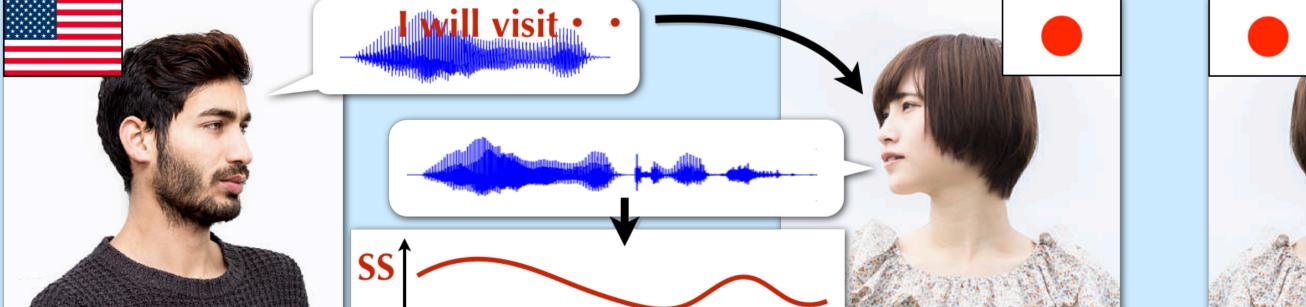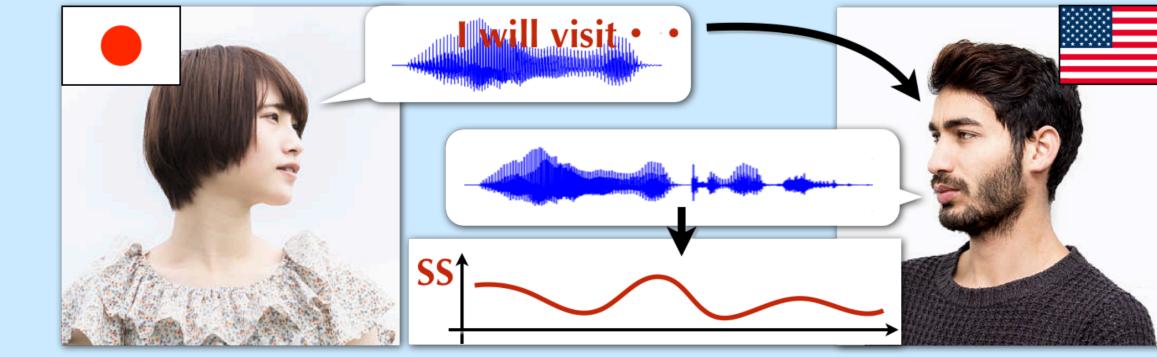   Both methods are too expensive to be used in classrooms.

Q: How to calculate comprehensibility in an inexpensive way?
- Objective assessment on intelligibility [Bernstein'03, Minematsu+'11]
  - Transcription or **oral repetition** is done **after** hearing L2 utterances.
  - Transcription or repetition allows waiting and guessing. ➡ **offline**
- Objective assessment on comprehensibility using **modified** repetition [Inoue+'18]
  - Repetition with almost no waiting or guessing ➡ **shadowing!!!**
  - Native listeners' **reverse** shadowing of L2 utterances!!! ➡ **online**

Conventional form of shadowing　　**Proposed form of shadowing**
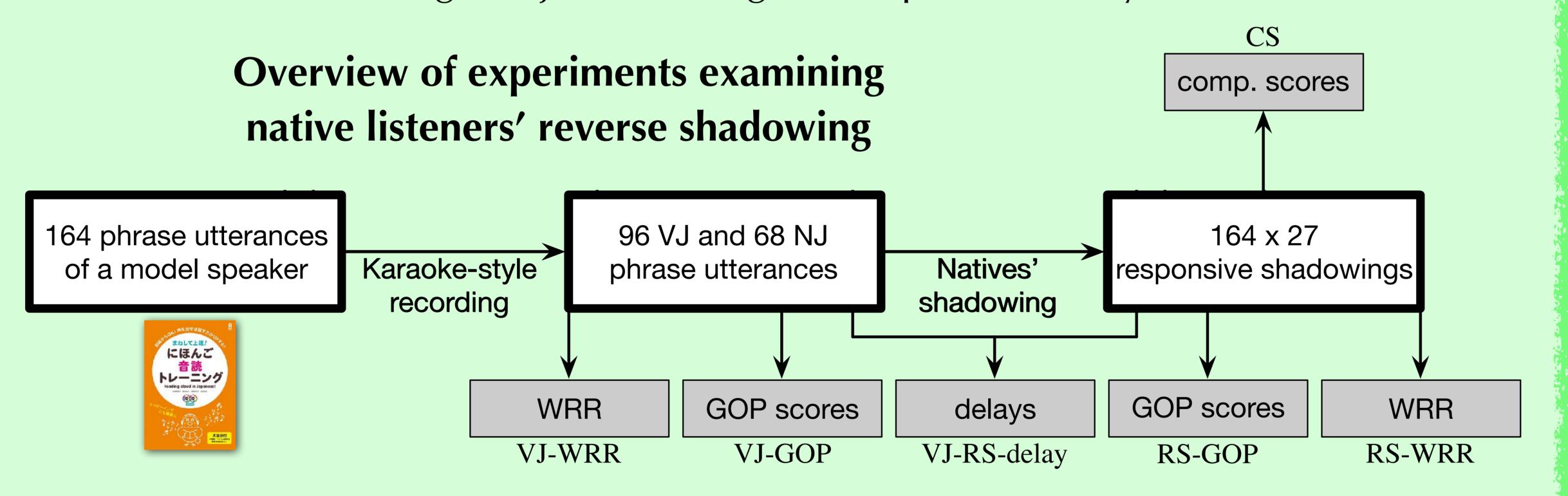
SS = Smoothness of Shadowing → GOP

- Learners' SS is automatically predicted. [Luo+'10][Yue+'17][Kabashima+'18]

NATIVE LISTENERS' REVERSE SHADOWING

Recording of L2 read sentences or phrases
- Vietnamese learners of Japanese (L1= 🇻🇳 , L2= 🇯🇵)
  - 6 intermediate and 6 advanced learners
  - Read sentences were also collected from natives as reference.
- Sentences were selected from an intermediate-level textbook.
  - Using CD audios of the textbook, Karaoke-style recording was done with speaking rate controlled. よろしくお願いいたします。
  - All the learners and native speakers read aloud 164 phrases from the textbook.

Native listeners' reverse shadowing [Inoue+'18]
- 27 native shadowers shadowed 96 VJ read phrases and 68 NJ read phrases.
- After each shadowing, subjective rating of comprehensibility was done. (➡ **CS**)

Overview of experiments examining native listeners' reverse shadowing

Correlation analysis between CS and speech features
- WRR: Word Recognition Rate, calculated using a speech recognition system
- GOP: Goodness Of Pronunciation, obtained as posterior probabilities of the phonemes intended by learners calculated using a speech recognition module.
  - Widely used in CALL as baseline speech feature for pron. assessment.
- Delay of shadowing: average phoneme boundary gap bet. VJ and RS

Corr. of the speech features to CS
- RS-GOP >> VJ-GOP
- RS-WRR > VJ-WRR

VJ-GOP	VJ-WRR	
0.58	0.47	
RS-GOP	RS-WRR	VJ-RS-delay
0.74	0.53	-0.59

Native listeners' reverse shadowing is by far more informative than learners' speech to predict its comprehensibility.

Pros and cons of native listeners' reverse shadowing
- Pros: inexpensive and directly focusing on listeners' immediate impressions
- Cons: always requires native listeners as shadowers, which may need payment.
  ➡ Can be solved by inter-learner shadowing?

INTER-LEARNER SHADOWING

SS = 60
SS = "B+"
Logical feedback　　**Intuitive feedback**

utterances　　shadowings

ILS = A learner shadows others and is shadowed by others.
- Any learner is a native of a language and shadows others learning that language.
  - Inter-supportive framework among learners of different languages.
  - A shadowing version of Lang-8 (http://lang-8.com).

ILS can feedback "honest" impressions on L2 utterances.
- Many teachers tend to be generous (and politically correct) to learners.
- Generous (politically correct) shadowing is difficult and probably impossible to do.
  - Waiting and guessing is not allowed in shadowing.

ILS may be able to solve the problem of "lack of exposure".
- Many learners do not have good chances to be exposed to native listeners.
- Pronunciation of any learner is the most comprehensible pronunciation to him/her.
  - Any learner is the most generous assessor of his/her own pronunciation.
  - Difficult to guess how smoothly others can or cannot listen to him/her.

ILS may be able to generate more "intuitive" feedback.
- Natives' shadowability can be fed back **logically** using scores or statements.
- Foreign accented utterances with the same level of shadowability can be fed back to learners, which can work as much more **intuitive** feedback.
  - Chinese-accented Japanese utterances are used to explain how his pronunciation is viewed from native speakers in terms of comprehensibility (shadowability).
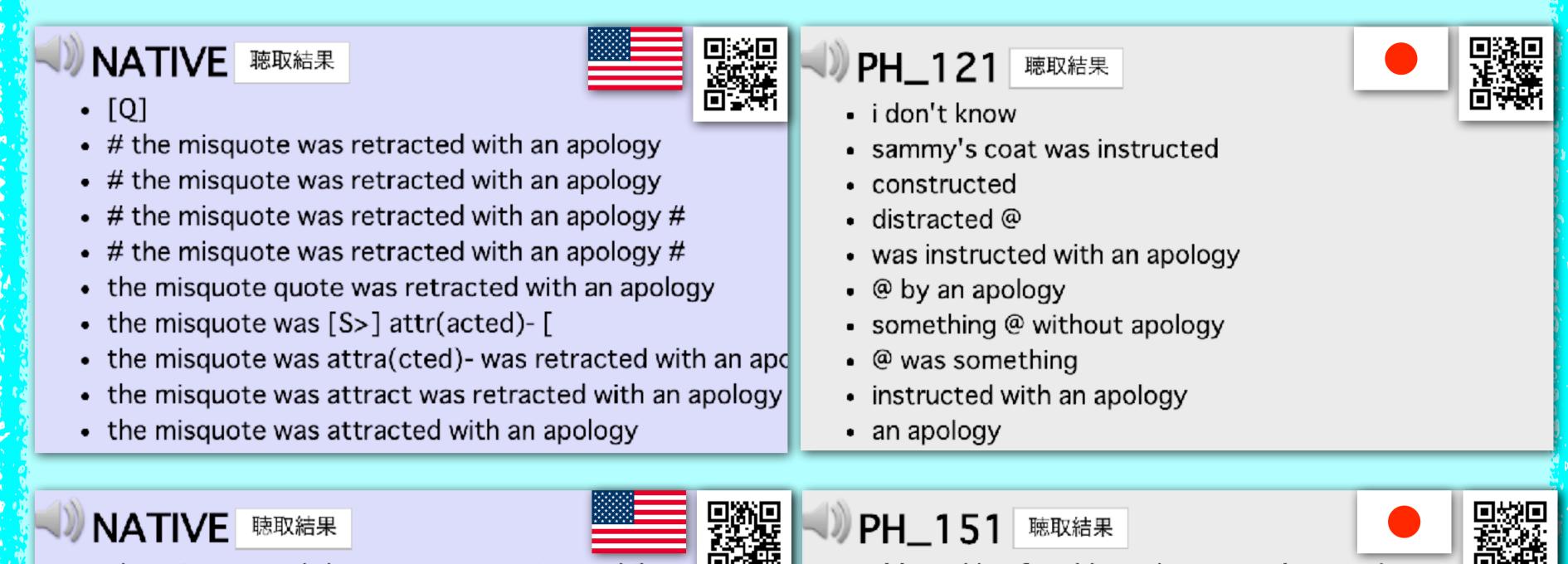 - So intuitive that accented speech feedback might discourage learners.

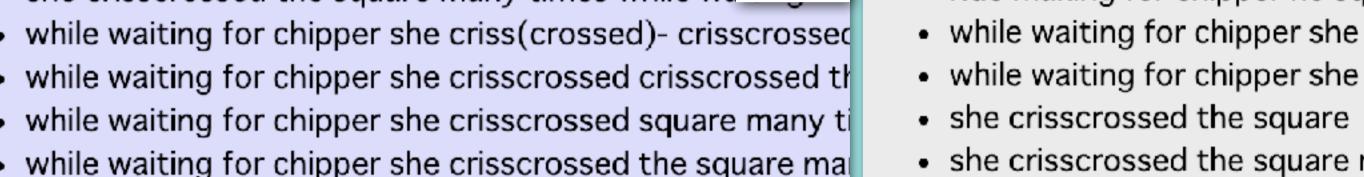### ILS requires collaboration and support from learners and teachers!!
- We may start soon a huge collection of L2 utterances and natives' shadowings.
  - **Please give us your name card to keep you updated!!!**
- Natives' shadowings can be viewed as **spoken annotation of comprehensibility**.
  - Any AI-based speech technology requires a huge corpus with annotation.

Examples of natives' *transcription* of AE and JE
- Speakers: natives and Japanese learners with low proficiency
- Transcribes: natives who have **never** talked with Japanese
- Each of read sentences was presented only once.

NATIVE 🇺🇸 | **PH_121** 🇯🇵
- [Q]
- # the misquote was retracted with an apology
- # the misquote was retracted with an apology
- # the misquote was retracted with an apology
- # the misquote was retracted with an apology #
- the misquote quote was retracted with an apology
- the misquote was [S>] attr(acted)- [
- the misquote was [S>] attr(acted)- [
- the misquote was attra(cted)- retracted with an apol
- the misquote was attract was retracted with an apology
- the misquote was attracted with an apology

- i don't know
- sammy's coat was instructed
- constructed
- distracted @
- was instructed with an apology
- @ by an apology
- something @ without apology
- @ was something
- instructed with an apology
- an apology

NATIVE 🇺🇸 | **PH_151** 🇯🇵
- she crisscrossed the square many times while wa
- while waiting for chipper she criss(crossed)- crisscrossed
- while waiting for chipper she crossed crisscrossed th
- while waiting for chipper she crisscrossed the square many ti
- while waiting for chipper she crisscrossed the square many times
- while waiting for chipper she crisscrossed the square ma
- while waiting for chipper she crisscrossed the square ma
- while waiting for chipper she crisscrossed the square ma

- ride making for chipper he squared many times
- while waiting for chipper she crossed the square man
- while waiting for chipper she crossed the square many tin
- she crisscrossed the square
- she crisscrossed the square many times
- wide waiting in chipper to increase something square m
- she the square many times
- while waiting for chipper she crisscrossed the scat square
- cry baby or chipper please close
- while waiting for chipper she crisscrossed that square ma

NATIVE 🇺🇸 | **PH_301** 🇯🇵
- artists exchanged autographs
- few artists exchanged autographs
- the two artist exchanged autographs
- the two artists es- exchanged autographs [N]
- the two artists exchanged *autographs
- the two artists exchanged autographs #
- the two artists extend @*
- the two artists exchanged autographs
- the two artists exchanged autographs

- "the two har- artists of sand hours"
- "the two artists have fun at work"
- "the two artists assigned are west"
- "@ one hour"
- "# the two parties of sign all worth"
- "# the two artists stood before us"
- "the two artists extend @*"
- "the two artists exchanged something"
- "the two @*"
- "hourglass"

- More examples of transcription are found at [QR] with [Chrome].