Cross-linguistic Variation in Phonemic Decomposition

SLE 2017, SEP 12, 2017, ZÜRICH, SWITZERLAND
WORKSHOP ON LINGUISTIC TYPOLOGY AND CROSS-LINGUISTIC PSYCHOLINGUISTICS

TSUNG-YING CHEN
DEPARTMENT OF FOREIGN LANGUAGES AND LITERATURE
NATIONAL TSING HUA UNIVERSITY, TAIWAN

JAMES MYERS
GRADUATE INSTITUTE OF LINGUISTICS
NATIONAL CHUNG CHENG UNIVERSITY, TAIWAN

Our thanks to...

- The Ministry of Science and Technology, Taiwan:
  MOST-103-2410-H-194-119-MY3
  MOST-106-2410-H-194-055-MY3
- Todd Bailey, James Kirby, and Anna Veres-Székely for sharing their experimental data
- Assistants: You-Chu Chang, Kuei-Yeh Chen, Pei-Shan Chen, Yi-Hsin Lin, Mei-Jun Liu, Hsiao-Yin Pan, Si-Qi Su
- Our many participants

Overview

- Typological variation in syllable complexity and phonemic decomposition
- Cross-linguistic test (I): Wordlikeness judgments in English, Mandarin, and Cantonese
- Cross-linguistic test (II): Picture naming latencies in seven languages
- Implications for cross-linguistic psycholinguistics

Overview

- **Typological variation in syllable complexity and phonemic decomposition**
- Cross-linguistic test (I): Wordlikeness judgments in English, Mandarin, and Cantonese
- Cross-linguistic test (II): Picture naming latencies in seven languages
- Implications for cross-linguistic psycholinguistics

Syllable complexity & Cross-linguistic variation

- **Languages vary in possible syllable structures** (Haspelmath et al., 2005)

  Simple = max CV (e.g., Hawaiian; *Mele Kalikimaka!*)

  Moderately complex = max CCVC (e.g., Mandarin; [ljaŋ])

  Complex = beyond CCVC (e.g., English; [stɹɛŋθs])

- **Languages thus also vary in the number of lexical syllable types**

  English: 12,000 (e.g., Levelt et al., 1999)
  Mandarin: 1,300 (including tones; e.g., Myers, 2015)

Syllable complexity & Phonemic decomposition

- **Hypothesis:**

Simpler/fewer syllables = Less phonemic decomposition

- **Some suggestive evidence:**

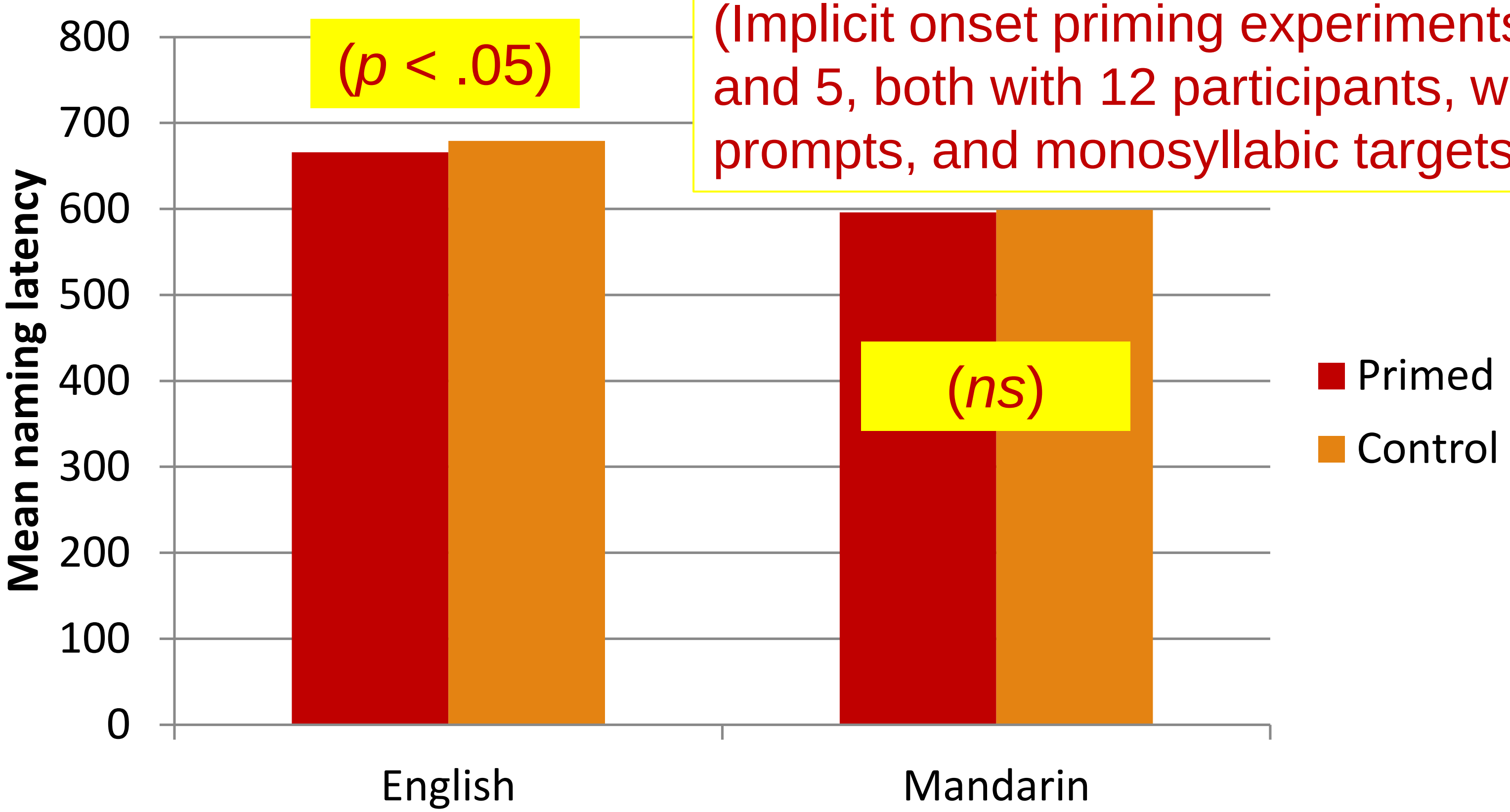
English – Phoneme priming in production (O'Seaghdha et al., 2010) and phoneme > syllable advantage in perception (Norris & Cutler, 1998)

Mandarin – No phoneme priming in production (O'Seaghdha et al., 2010) and lexical syllable superiority effect in phoneme perception (Tseng et al. 1996)

Phonemic decomposition in English vs. Mandarin

O’Seaghdha et al. (2010)

(Implicit onset priming experiments 3 and 5, both with 12 participants, written prompts, and monosyllabic targets)



(p < .05)

(*ns*)

Phonemic decomposition: A simple diagnostic

- **Two lexical influences** (Luce & Large 2001)

Phonotactic probability (PP) – Probability of subsyllabic phoneme sequences, *depends on phonemic decomposition*

Neighborhood density (ND) – Overall similarity to lexical words, *does not depend on phonemic decomposition*

- **Predictions:**
  - **Effect sizes with strong phonemic decomposition: PP » ND** (e.g., English)
  - **Effect sizes with weak phonemic decomposition: ND » PP** (e.g., Mandarin)

Overview

- Typological variation in syllable complexity and phonemic decomposition
- **Cross-linguistic test (I): Wordlikeness judgments in English, Mandarin, and Cantonese**
- Cross-linguistic test (II): Picture naming latencies in seven languages
- Implications for cross-linguistic psycholinguistics

Wordlikeness judgments: Reanalyzing three studies

- **Nonword acceptability:** e.g., *blick* vs. **bnick*
  - **Higher PP = Higher acceptability**
  - **Higher ND = Higher acceptability**

  (Can be deconfounded via regression; Bailey & Hahn, 2001)
- **Test languages**

  English: Complex syllables

  Mandarin: Moderately complex

  Cantonese: Moderately complex
- **Predictions**

English (**PP » ND**), Mandarin and Cantonese (**ND » PP**)

Wordlikeness judgments: Study procedures

- **English** (Bailey & Hahn, 2001, Exp 2)

  24 participants, **259 spoken monosyllabic nonwords**

  Nine-point Likert scale (1 = very atypical, 9 = very typical)

- **Mandarin** (Myers, 2015)

  110 participants, **3274 monosyllabic nonwords** written in Zhuyin Fuhao (Taiwan's onset/rime-based "pinyin")

  Binary scale (0 = 'unlike Mandarin', 1 = 'like Mandarin')

- **Cantonese** (Kirby & Yu, 2007)

  10 participants, **270 spoken monosyllabic nonwords**

  Seven-point Likert scale (1 = very poor, 7 = very good)

Wordlikeness judgments: Quantification & analysis

- **Definition of predictors**

PP – Transition probability in bigrams
ND – Number of lexical monosyllables differing in just one element (tone ignored in Myers, 2015, to simplify bigrams)

- **Making judgment scales uniform**

By-item mean judgments already in 0-1 range (Mandarin acceptance rates) or after rescaling (English, Cantonese), and transformed via arcsine square root.

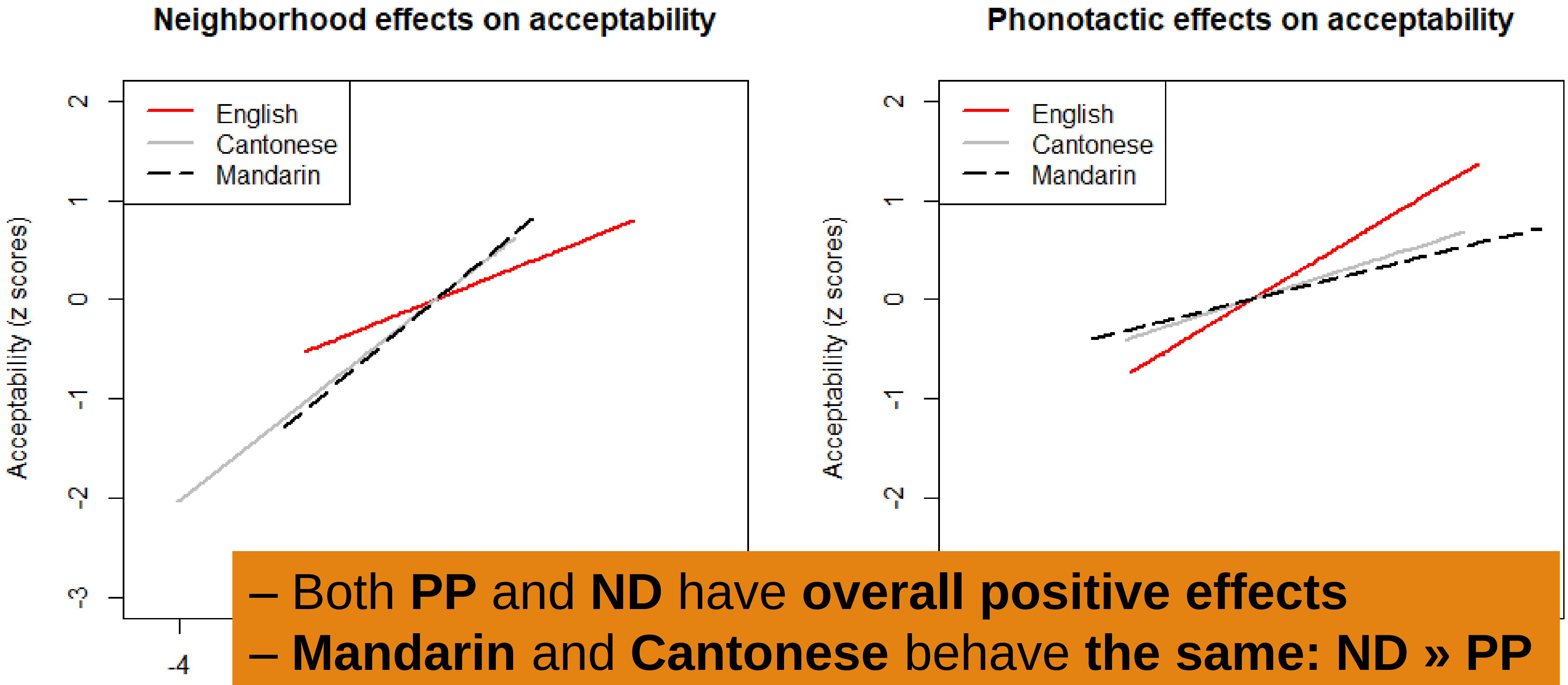
- **Standardizing**

By-item ND, PP, judgments *z*-scored within each language

- **Linear regression on by-item values**

Response ~ Language × (PP + ND)

Wordlikeness judgments: Results and discussion


Neighborhood effects on acceptability

Phonotactic effects on acceptability

- – Both **PP** and **ND** have **overall positive effects**
- – **Mandarin** and **Cantonese** behave **the same: ND » PP**
- – **English** has **weakest ND** and **strongest PP** effects

Overview

- Typological variation in syllable complexity and phonemic decomposition
- Cross-linguistic test (I): Wordlikeness judgments in English, Mandarin, and Cantonese
- **Cross-linguistic test (II): Picture naming latencies in seven languages**
- Implications for cross-linguistic psycholinguistics

Picture naming latencies: Seven test languages

- **Picture naming in seven languages** (Bates et al., 2003)

	Syllable	OrthUnit	OrthDepth
Bulgarian	Complex	Phoneme	Shallow
English	Complex	Phoneme	Mid
German	Complex	Phoneme	Mid
Hungarian	Complex	Phoneme	Shallow
Italian	ModComplex	Phoneme	Shallow
Mandarin	ModComplex	Syllable	Deep
Spanish	ModComplex	Phoneme	Shallow

- **520 pictures, 30 participants for German, 50 participants for each of the other six languages.**

Picture naming latencies: Quantifying variables

- **ND and PP were recalculated from free electronic dictionaries**
  English (Lenzo, 2014), Mandarin (Denisowski et al., 2016), Spanish (Cuetos et al., 2011), the rest (Deri & Knight, 2016)

- **PP = Mean transition probability in bigrams**
  (tone ignored in Mandarin)

- **(Inverse) ND (neighborhood sparsity) = PLD20**
  (Yarkoni et al., 2008) Mean phonological Levenshtein (edit) distance from the twenty nearest lexical neighbors
  (more effective measure for polysyllabic words)

Picture naming latencies: Expected patterns

- **Different effects of phonotactics and neighbors on picture naming, depending on syllable types**

- **Higher PP = Stronger prelexical preparation**
→ Faster responses
(Bulgarian, English, German, Hungarian) »
(Italian, Mandarin, Spanish)

- **Higher PLD20 (inverse ND) = Weaker postlexical activation**
→ Slower responses
(Italian, Mandarin, Spanish) »
(Bulgarian, English, German, Hungarian)

Picture naming latencies: Statistical analysis

- **Linear mixed-effects regression**

– **Dependent variable** – Reaction time (log-transformed)

– **Independent variables** – Inverse ND (PLD20), PP, eight nuisance variables (e.g., lexical frequency), and their interaction with syllable complexity

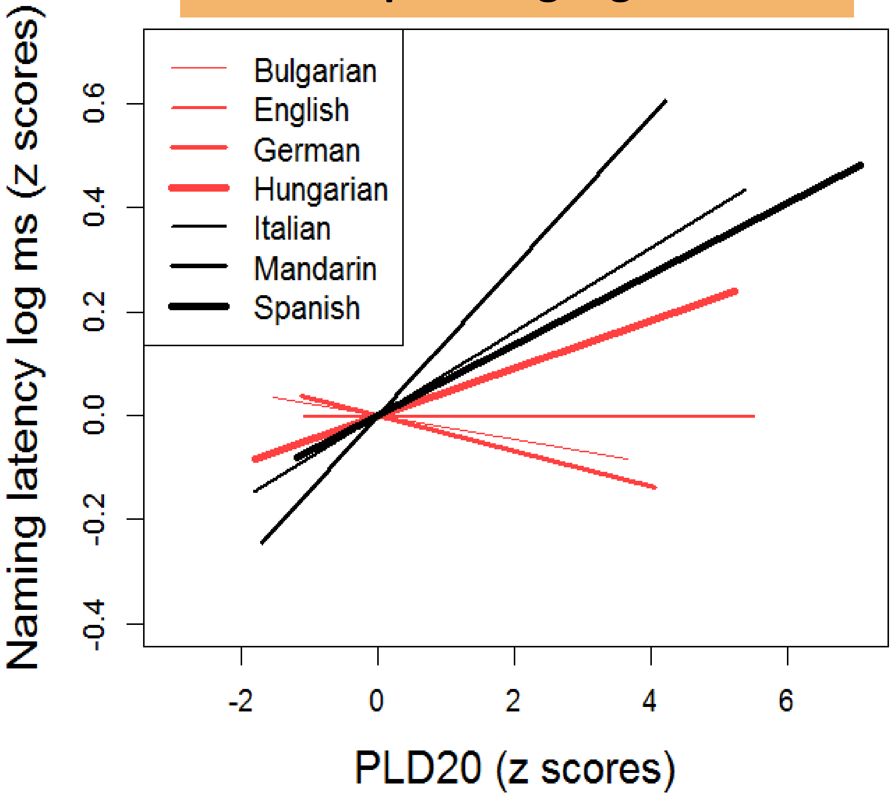
– **Random intercepts for pictures and languages**

– **All variables were *z*-scored within language**

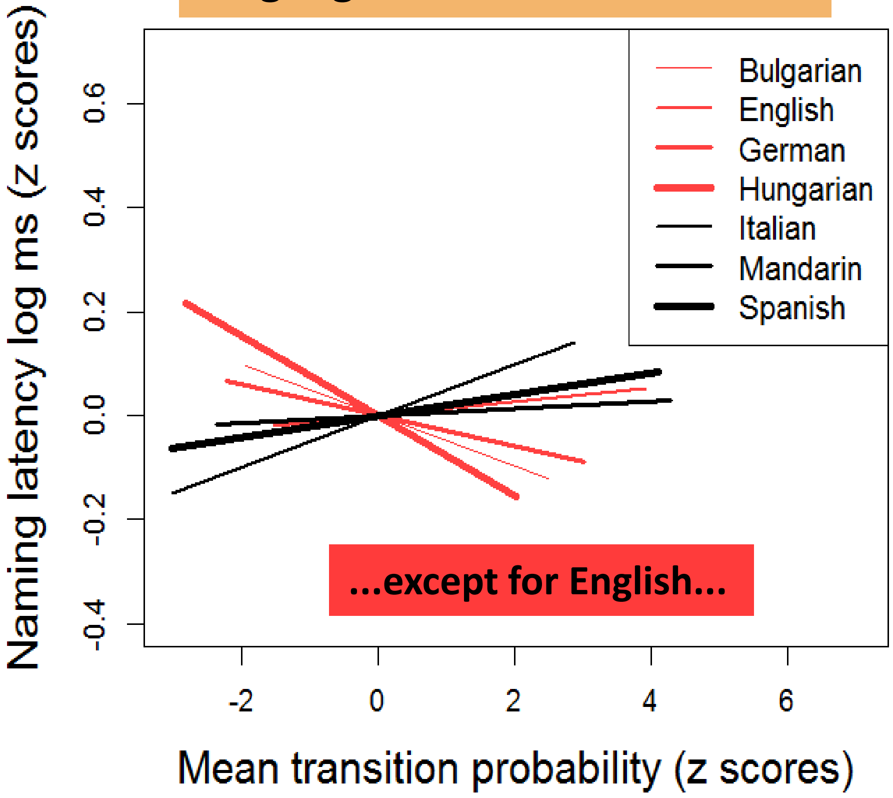
Response ~ SylComplex x (Nuisances + PP + InvND)

Picture naming latencies:
Results and discussion

Stronger (inverse) ND effect for ModComplex languages



Stronger PP effect for Complex languages



...except for English...

Overview

- Typological variation in syllable complexity and phonemic decomposition
- Cross-linguistic test (I): Wordlikeness judgments in English, Mandarin, and Cantonese
- Cross-linguistic test (II): Picture naming latencies in seven languages
- **Implications for cross-linguistic psycholinguistics**

Cross-linguistic psycholinguistics: Dealing with confounds

- **Our databases are still too small:**
  - **Syllable complexity vs. inventory vs. orthography**
    Mandarin differs from Spanish and Italian in many ways
  - **Microvariation?**
    Are Mandarin and Cantonese really processed the same?
- **Expanding the typological survey**
  - **Existing databases to exploit**
    Lexical decision latencies in English, Dutch, French, Malay…
  - **Collect our own wordlikeness judgments**
    Hakka and Southern Min (no orthographic influence?)
    Japanese (moderately complex, but different orthography)
    ... and as many other languages as we can manage...

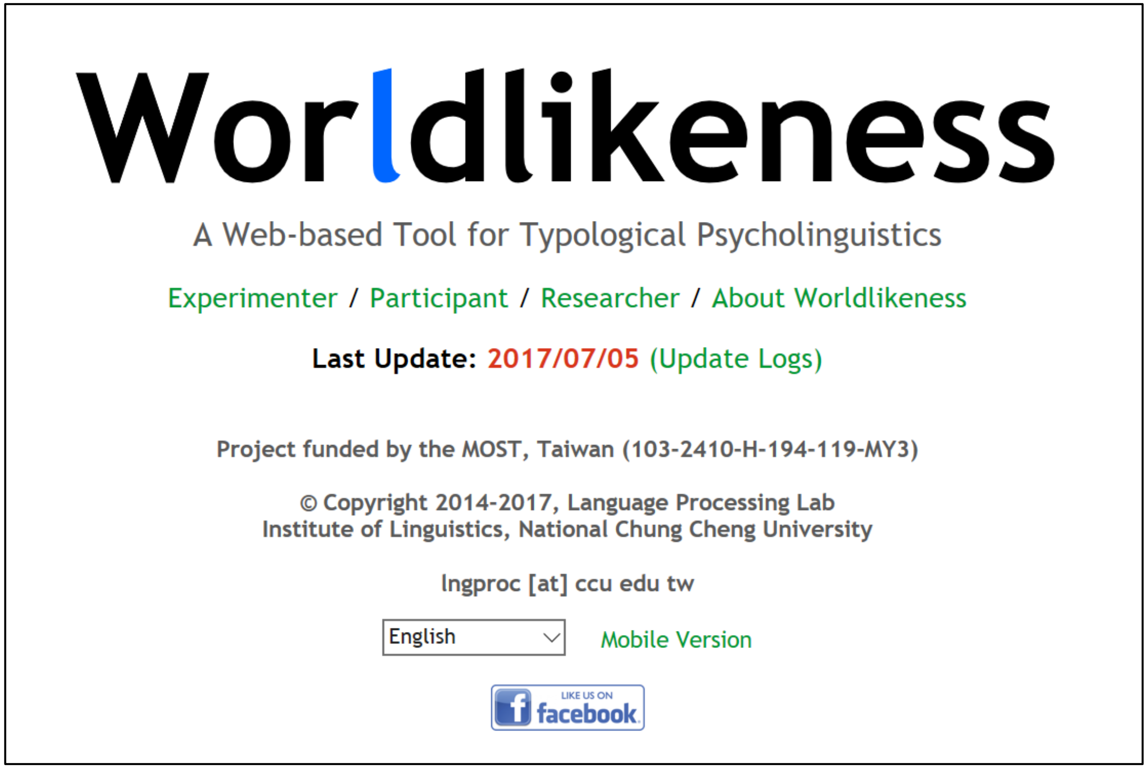
Cross-linguistic psycholinguistics: Making it feasible

- **Avoiding task-related confounds**
  – Different scales may be OK: binary vs. Likert scale
  – But task matters: wordlikeness vs. picture naming
- **Methodological consistency is thus crucial**
- **Yet no single team can test a sufficient number and variety of languages for a proper regression**

Let the internet help:
Web-based experimentation + Web-based data sharing

Worldlikeness:
A Web application for typological psycholinguistics

- https://Worldlikeness.org (Chen & Myers 2017; Myers 2016)



Worldlikeness

A Web-based Tool for Typological Psycholinguistics

Experimenter / Participant / Researcher / About Worldlikeness

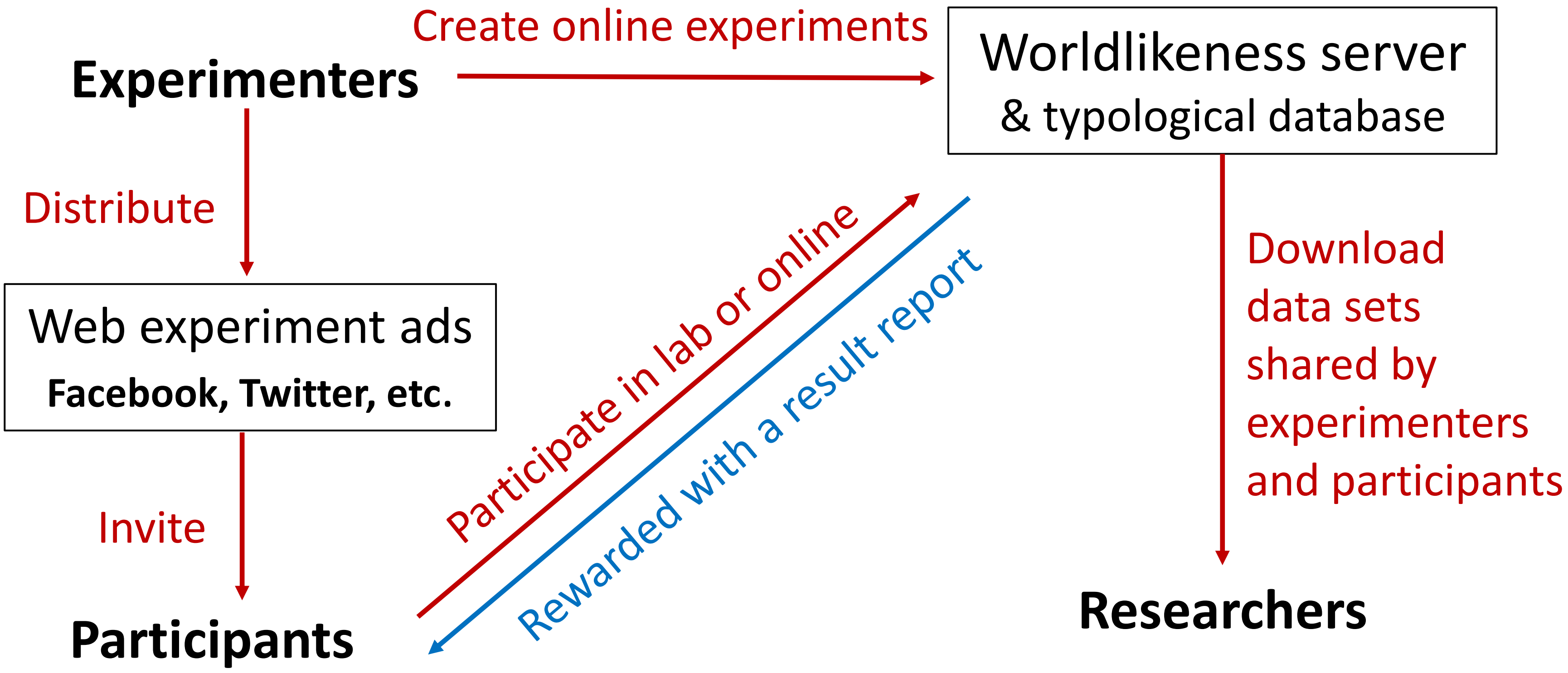
Last Update: 2017/07/05 (Update Logs)

Project funded by the MOST, Taiwan (103-2410-H-194-119-MY3)

© Copyright 2014-2017, Language Processing Lab
Institute of Linguistics, National Chung Cheng University

lngproc [at] ccu edu tw

Worldlikeness:
Overall architecture



Experimenters

Create online experiments

Worldlikeness server
& typological database

Distribute

Web experiment ads
Facebook, Twitter, etc.

Invite

Participants

Participate in lab or online

Rewarded with a result report

Download
data sets
shared by
experimenters
and participants

Researchers

Worldlikeness: Special features

- **Limited parameters to increase consistency**

– Focused on wordlikeness

- **Privacy protections to encourage participation**

– Fully anonymous
– Full control of data authorization

- **Yet also facilitates and encourages data sharing**

– Share more, do more
– Most-open authorization option selected by default

- **Rapid data collection via Web crowdsourcing**

– 16,000 judgments from 160 participants collected via Facebook in less than two weeks (Chen & Myers, in prep.)

Thank you!

TSUNG-YING CHEN
chen.ty@mx.nthu.edu.tw

JAMES MYERS
Lngmyers@ccu.edu.tw

References (1/4)

Bailey, T. M., & Hahn, U. (2001). Determinants of wordlikeness: Phonotactics or lexical neighborhoods? *Journal of Memory & Language, 44*, 569-591.

Bates, E., et al. (2003). Timed picture naming in seven languages. *Psychonomic Bulletin & Review, 10*(2), 344-380.

Chen, T.-Y., & Myers, J. (2017). Worldlikeness: A Web-based tool for typological psycholinguistic research. *University of Pennsylvania Working Papers in Linguistics, 23*(1), Article 4, 20-30.

Chen, T.-Y., & Myers, J. (In prep.). Worldlikeness: A Web application for typological psycholinguistic. Ms., National Tsing Hua University and National Chung Cheng University.

References (2/4)

Cuetos, F., Glez-Nosti, M., Barbón, A., & Brysbaert, M. (2011). SUBTLEX-ESP: Spanish word frequencies based on film subtitles. *Psicológica, 32*, 133-143.

Denisowski, P. A. et al. (2016). CC-CEDICT (version cedict_ts.u8). https://www.mdbg.net/chindict/chindict.php?page=cedict. Retrieved November 11, 2016.

Deri, A., & Knight, K. (2016). Grapheme-to-phoneme models for (almost) any language. *Proceedings of the 54th Annual Meeting of the Association for Computational Linguistics*, 399-408.

Haspelmath, M., Dryer, M.S., Gil, D., & Comrie, B. (Eds.) (2005). *The world atlas of language structure*. Oxford University Press.

Kirby, J. P., & Yu, A. C. L. (2007). Lexical and phonotactic effects on wordlikeness judgments in Cantonese. *Proceedings of the International Congress of Phonetic Sciences, 16*, 1389-1392.

References (3/4)

Lenzo, K. et al. (2014). Carnegie Mellon University Pronouncing Dictionary (version 0.7b). http://www.speech.cs.cmu.edu/cgi-bin/cmudict. Retrieved November 14, 2016.

Levelt, W. J., Roelofs, A., & Meyer, A. S. (1999). A theory of lexical access in speech production. *Behavioral and Brain Sciences, 22*(01), 1-38.

Luce, P. A., & Large, N. R. (2001). Phonotactics, density, and entropy in spoken word recognition. *Language & Cognitive Processes, 16*(5/6), 565-581.

Myers, J. (2015). Markedness and lexical typicality in Mandarin acceptability judgments. *Language & Linguistics, 16*(6), 791-818.

Myers, J. (2016). Meta-megastudies. *The Mental Lexicon, 11*(3), 329-349.

References (4/4)

Norris, D., & Cutler, A. (1988). The relative accessibility of phonemes and syllables. *Perception & Psychophysics, 43*(6), 541-550.

O'Seaghdha, P. G., Chen, J.-Y., & Chen, T.-M. (2010). Proximate units in word production: Phonological encoding begins with syllables in Mandarin Chinese but with segments in English. *Cognition, 115*, 282-302.

Tseng, C.-H., Huang, K.-Y., & Jeng, J.-Y. (1996). The role of the syllable in perceiving spoken Chinese. *Proceedings of the National Science Council, Part C: Humanities and Social Sciences, 6*(1), 71-86.

Yarkoni, T., Balota, D., & Yap, M. (2008). Moving beyond Coltheart's N: A new measure of orthographic similarity. *Psychonomic Bulletin & Review, 15*(5), 971-979.

Appendix: Bates et al. (2003) nuisance variables

- Lexical frequency
- Picture quality (via pretest judgments)
- Fricative onset
- Word length in phonemes
- Number of alternative names
- Number of names shared across pictures
- Naming consistency across participants
- Naming consistency within each participant

Return