Cross-linguistic Variation in Phonemic Decomposition

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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
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- 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
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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; [ljan])
  - Complex = beyond CCVC (e.g., English; [stεŋθs])

- **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)
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)
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Wordlikeness judgments: Reanalyzing three studies

- **Nonword acceptability**: e.g., \textit{blick} vs. \textit{*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

- Both PP and ND have overall positive effects
- Mandarin and Cantonese behave the same: ND » PP
- English has weakest ND and strongest PP effects
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Picture naming latencies: Seven test languages

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

<table>
<thead>
<tr>
<th></th>
<th>Syllable</th>
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<th>OrthDepth</th>
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<tr>
<td>Bulgarian</td>
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<td>Mid</td>
</tr>
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<tr>
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<td>ModComplex</td>
<td>Syllable</td>
<td>Deep</td>
</tr>
<tr>
<td>Spanish</td>
<td>ModComplex</td>
<td>Phoneme</td>
<td>Shallow</td>
</tr>
</tbody>
</table>

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

Experimenters → Create online experiments
Web experiment ads → Distribute
Facebook, Twitter, etc. → Invite
Participants

Worldlikeness server & typological database

Researchers → Download data sets shared by experimenters and participants
Participate in lab or online → Rewarded with a result report
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)


References (2/4)


References (3/4)


References (4/4)


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