Gradience at the syntax-phonology interface
Evidence from Mandarin and Wenzhounese

Chen Xie (DPhil student)
Faculty of Linguistics, Philology and Phonetics
Hertford College, University of Oxford
chen.xie@ling-phil.ox.ac.uk
https://users.ox.ac.uk/~kell5077/
Roadmap

1. Introduction

2. The syllabicity constraint
   - In Mandarin
   - In Wenzhounese

3. Theoretical implications for LFG

4. Conclusion
Roadmap

1. Introduction

2. The syllabic constraint
   • In Mandarin
   • In Wenzhounese

3. Theoretical implications for LFG

4. Conclusion
1. Introduction

Target languages

- Mandarin Chinese (based on previous work)
- Wenzhounese: a southern Wu dialect (my field work)

Shared properties

- Canonical word order: SVO
- Topic prominence (Li & Thompson 1976)
- Many words have monosyllabic and disyllabic variants
1. Introduction

For example, in Mandarin, • ‘to plant’ zhong or zhong.zhi
• ‘tree’ shu or shu.mu

Four logically possible combinations for the VP ‘to plant trees’

<table>
<thead>
<tr>
<th>Syllabicity</th>
<th>Verb</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. 2+2</td>
<td>zhong.zhi</td>
<td>shu.mu</td>
</tr>
<tr>
<td>b. 1+2</td>
<td>zhong</td>
<td>shu.mu</td>
</tr>
<tr>
<td>c. 1+1</td>
<td>zhong</td>
<td>shu</td>
</tr>
<tr>
<td>d. 2+1</td>
<td>zhong.zhi</td>
<td>shu</td>
</tr>
</tbody>
</table>
1. Introduction

All of them are syntactically well-formed, but (d) is far less acceptable

<table>
<thead>
<tr>
<th></th>
<th>Syllabicity</th>
<th>Verb</th>
<th>Object</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>2+2</td>
<td>zhong.zhi</td>
<td>shu.mu</td>
</tr>
<tr>
<td>b.</td>
<td>1+2</td>
<td>zhong</td>
<td>shu.mu</td>
</tr>
<tr>
<td>c.</td>
<td>1+1</td>
<td>zhong</td>
<td>shu</td>
</tr>
<tr>
<td>d.</td>
<td>2+1</td>
<td>zhong.zhi</td>
<td>shu</td>
</tr>
</tbody>
</table>

The syllabicity constraint:

2+1 VPs (disyllabic verb + monosyllabic object) are prosodically ill-formed¹

¹There is a similar constraint on nominal compounds (see, e.g., Feng 1997).
1. Introduction

Research questions

1. How much less acceptable are 2+1 VPs in Mandarin?
2. How much less acceptable are 2+1 VPs in Wenzhounese?
3. Implications for modularity
   • Does phonology have (direct) access to syntactic information?
   • How should the syllabicity constraint be formalised in LFG?
4. Implications for grammaticality
   • Binary or gradient?
   • How can LFG incorporate gradient grammaticality?
1. Introduction

2. The syllabicity constraint
   - In Mandarin
   - In Wenzhounese

3. Theoretical implications for LFG

4. Conclusion
2. The syllabicity constraint in Mandarin

Duanmu’s (2012) corpus study:

The token count of 2+1 VPs is exceptionally low, which would be unexpected if monosyllabic and disyllabic objects are freely variable.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Token</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>711</td>
<td>16.2%</td>
</tr>
<tr>
<td>1+2</td>
<td>838</td>
<td>19.91%</td>
</tr>
<tr>
<td>1+1</td>
<td>2,749</td>
<td>62.8%</td>
</tr>
<tr>
<td>2+1</td>
<td>81</td>
<td>1.8%</td>
</tr>
</tbody>
</table>
2. The syllabic constraint in Mandarin

Duanmu’s (2012) corpus study:

The token count of 2+1 VPs is exceptionally low, which would be unexpected if monosyllabic and disyllabic objects are freely variable.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Token</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>711</td>
<td>16.2%</td>
</tr>
<tr>
<td>1+2</td>
<td>838</td>
<td>19.91%</td>
</tr>
<tr>
<td>1+1</td>
<td>2,749</td>
<td>62.8%</td>
</tr>
<tr>
<td>2+1</td>
<td>81</td>
<td>1.8%</td>
</tr>
</tbody>
</table>
2. The syllabicity constraint in Mandarin

Judgment study (adapted from Duanmu et al. 2018):
Roadmap

1. Introduction

2. The syllabicity constraint
   • In Mandarin
   • In Wenzhounese

3. Theoretical implications for LFG

4. Conclusion
2. The syllabicity constraint in Wenzhounese

Experiment 1

• Production test: Is a disyllabic verb more likely to induce a disyllabic object (i.e. 2+2) than a monosyllabic verb is (i.e. 1+2)?

• Judgment test: Are 2+1 VPs considered less acceptable than 2+2 VPs?
2. The syllabicity constraint in Wenzhounese

Experiment 1: Procedure

• 32 native speakers of Wenzhounese (note: they also speak Mandarin)
• Production test: Wenzhounese sentences elicited
• Judgment test: listened to and rated audio stimuli
2. The syllabicity constraint in Wenzhounese

Production test: Results

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>71%</td>
</tr>
<tr>
<td>1+2</td>
<td>46%</td>
</tr>
<tr>
<td>1+1</td>
<td>54%</td>
</tr>
<tr>
<td>2+1</td>
<td>29%</td>
</tr>
</tbody>
</table>

Monosyllabic verb
2. The syllabicity constraint in Wenzhounese

Production test: Results

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>71%</td>
</tr>
<tr>
<td>1+2</td>
<td>46%</td>
</tr>
<tr>
<td>1+1</td>
<td>54%</td>
</tr>
<tr>
<td>2+1</td>
<td>29%</td>
</tr>
</tbody>
</table>
2. The syllabicity constraint in Wenzhounese

Production test: Results

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Percentage</th>
<th>Likelihood ratio test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>71%</td>
<td>$\chi^2(1) = 20.90,$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$p &lt; 0.0001$</td>
</tr>
<tr>
<td>1+2</td>
<td>46%</td>
<td></td>
</tr>
<tr>
<td>1+1</td>
<td>54%</td>
<td></td>
</tr>
<tr>
<td>2+1</td>
<td>29%</td>
<td></td>
</tr>
</tbody>
</table>

- Compared to a monosyllabic verb, a disyllabic verb is significantly more likely to induce a disyllabic object
- 2+1 VPs are disfavoured in production
2. The syllabic constraint in Wenzhounese

Production test: Compare with 2+1 and 2+2 VPs in Mandarin

<table>
<thead>
<tr>
<th>Language</th>
<th>2+2</th>
<th>2+1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandarin</td>
<td>89.8%</td>
<td>10.2%</td>
</tr>
<tr>
<td>Wenzhounese</td>
<td>71%</td>
<td>29%</td>
</tr>
</tbody>
</table>
2. The syllabicity constraint in Wenzhounese

Production test: Compare with 2+1 and 2+2 VPs in Mandarin

Similarity: 2+1 VPs are disfavoured in both varieties
Difference: 2+1 VPs are more disfavoured in Mandarin than in Wenzhounese
Implication: Strong vs. weaker constraint
2. The syllabicity constraint in Wenzhounese

Judgment test: Results

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Rating</th>
<th>Z-score</th>
<th>SD</th>
<th>Likelihood ratio test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>6.26</td>
<td>0.68</td>
<td>0.40</td>
<td>$\chi^2(1) = 16.37$, $p &lt; 0.0001$</td>
</tr>
<tr>
<td>2+1</td>
<td>5.96</td>
<td>0.52</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

- Both 2+1 and 2+2 VPs are acceptable (rated above 4)
- But 2+1 VPs are significantly less acceptable than 2+2 VPs
2. The syllabicity constraint in Wenzhounese

Judgment test: Linking hypothesis

Grammaticality vs. Acceptability

• The relation is indirect (Lau et al. 2017; Phillips et al. 2021)
• There can be mismatches (Haider 2019)

  a. *The rat the cat the dog chased killed ate the malt.
  b. *The key to the cabinets are rusty.
2. The syllabicity constraint in Wenzhounese

Judgment test: Linking hypothesis

• The stimuli in this experiment are simple SVO sentences, so the lower acceptability of 2+1 VPs is unlikely to result from processing difficulties.
• The results of the judgment test are corroborated by the results of the production test, according to which the preference for 2+2 over 2+1 VPs is high but not absolute.
• Therefore, at least in this experiment, acceptability is a reliable indicator of grammaticality (see also Almeida 2014 and Featherston 2005)
2. The syllabicity constraint in Wenzhounese

Judgment test: Interpretation

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Rating</th>
<th>Z-score</th>
<th>SD</th>
<th>Likelihood ratio test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>6.26</td>
<td>0.68</td>
<td>0.40</td>
<td>$\chi^2(1) = 16.37$, $p &lt; 0.0001$</td>
</tr>
<tr>
<td>2+1</td>
<td>5.96</td>
<td>0.52</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

• Both 2+1 and 2+2 VPs are grammatical if grammaticality is binary.
• But 2+1 VPs are less grammatical than 2+2 VPs.
• Binary grammaticality misses the generalisation.
2. The syllabicacy constraint in Wenzhounese

Judgment test: Compare with the judgement test in Mandarin

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Rating</th>
<th>Z-score</th>
<th>SD</th>
<th>Likelihood ratio test</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>6.26</td>
<td>0.68</td>
<td>0.40</td>
<td>$\chi^2(1) = 16.37, p &lt; 0.0001$</td>
</tr>
<tr>
<td>2+1</td>
<td>5.96</td>
<td>0.52</td>
<td>0.61</td>
<td></td>
</tr>
</tbody>
</table>

In Mandarin

- median of rating ≈ 6 for 2+2 VPs
- median of rating ≈ 2 for 2+1 VPs

The syllabicacy constraint

- Strong in Mandarin but weaker in Wenzhounese
2. The syllabic constraint in Wenzhounese

Experiment 2

• Topic prominence may affect word order
• What if the object is displaced?
• What is the target of the syllabic constraint?
  • A local domain [V NP], or
  • The head-dependent relation regardless of word order
2. The syllabicity constraint in Wenzhounese

Experiment 2

A sample stimulus

Object: *tsʰo/tɕi-tsʰo*  Verb: *sei.tɕi*  Object: *car/petrol-car*  Verb: *design*

PFV  SFP  NEG  Q

‘Have you finished designing the car?’
2. The syllabicity constraint in Wenzhounese

Experiment 2

- 30 participants, Wenzhounese-Mandarin bilinguals
- Listened to audio stimuli and asked to rate against a seven-point scale
- No significant difference ($\chi^2(1) = 0.66, p = 0.42$)
2. The syllabicity constraint

Summary:

• 2+1 VPs are dispreferred in production and acceptability judgment.
• Wenzhounese is more tolerant of 2+1 VPs than Mandarin is.
• The syllabicity constraint is strong in Mandarin but weaker in Wenzhounese, which challenges binary grammaticality.
• The syllabicity constraint only applies locally to the object governed by the verb.
Roadmap

1. Introduction

2. The syllabicity constraint
   - In Mandarin
   - In Wenzhounese

3. Theoretical implications for LFG

4. Conclusion
Q1: Is there a more general principle that subsumes the syllabicity constraint?

**Non-head stress** (Duanmu 2007: 146)

- In the syntactic structure [X XP] (or [XP X]), where X is the syntactic head and XP the syntactic nonhead, XP should be stressed.
- Asymmetrical tonal neutralisation cross-linguistically (Hyman 2019: 22)
Non-head stress + Metrical requirements (Duanmu 2012: 106)

a. Foot binary: A foot needs two syllables, i.e. (σσ)

b. Every stress represents a foot.

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Metrical structure¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2</td>
<td>(σσ)(σσ)</td>
</tr>
<tr>
<td>*2+1</td>
<td>(σσ)(σ)</td>
</tr>
<tr>
<td>1+2</td>
<td>σ(σσ)</td>
</tr>
<tr>
<td>1+1</td>
<td>(σσ)</td>
</tr>
</tbody>
</table>

¹Colour coding: blue for verbs and orange for objects
Q2: How do we formalise non-head stress in a modular way, given that phonology should not know the difference between head and non-head (or, relatedly, the head-adjunct distinction; Tamelan & Arka 2021)?

Step 1: The metrical structure is stored in the lexicon (Levelt 1999; Bögel 2015) e.g., ’to repair cars’ in Wenzhounese

<table>
<thead>
<tr>
<th></th>
<th>Monosyllabic</th>
<th>Disyllabic</th>
</tr>
</thead>
<tbody>
<tr>
<td>repair</td>
<td>[sou]</td>
<td>[sou.lei]</td>
</tr>
<tr>
<td>car</td>
<td>[tʃʰo]</td>
<td>[tʃʰi.tʃʰo]</td>
</tr>
</tbody>
</table>
3. Theoretical implications for LFG

Lexical entries for ‘repair’ in Wenzhounese

<table>
<thead>
<tr>
<th>s-form</th>
<th>(● FM) = sou</th>
<th>(● FM) = soulei</th>
</tr>
</thead>
<tbody>
<tr>
<td>λ(π(●)) = V</td>
<td>λ(π(●)) = V</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>p-form</th>
<th>/s o u/</th>
<th>/s ou le i/</th>
</tr>
</thead>
<tbody>
<tr>
<td>σ</td>
<td>(σσ)_{Ft}</td>
<td></td>
</tr>
</tbody>
</table>

Lexical entries for ‘car’ in Wenzhounese

<table>
<thead>
<tr>
<th>s-form</th>
<th>(● FM) = ts^h_0</th>
<th>(● FM) = tc^h its^h_0</th>
</tr>
</thead>
<tbody>
<tr>
<td>λ(π(●)) = N</td>
<td>λ(π(●)) = N</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>p-form</th>
<th>/ts^h_0/</th>
<th>/tc^h its^h_0/</th>
</tr>
</thead>
<tbody>
<tr>
<td>σ</td>
<td>(σσ)_{Ft}</td>
<td></td>
</tr>
</tbody>
</table>
3. Theoretical implications for LFG

Step 2: Prosodic phrasing (Selkirk 2011; Interface Harmony)

P-structure for 2+2 VPs

P-structure for 2+1 VPs
Step 3: Phrasal stress is assigned to the right edge of a Φ (cf. Dalrymple et al. 2019: 422), which must be realised on a binary foot (Duanmu 2012).
3. Theoretical implications for LFG

- Modularity
- Locality
3. Theoretical implications for LFG

Q3: How do we capture the difference between Mandarin and Wenzhounese?

• Mandarin: 2+1 VPs are strongly dispreferred
• Wenzhounese: 2+1 VPs are grammatical but less acceptable

Step 1: Assume OT-LFG (e.g. Bresnan 2000; Lowe 2016)
Step 2: Assume Stochastic OT (SOT), where constraints are weighted and there is a noise component that temporarily impacts the grammar (Boersma 1999)
3. Theoretical implications for LFG

(adapted from Boersma & Hayes 2001: 47, 49)

• $C_1 \gg C_2 \gg C_3$

• $C_1 - C_2 > C_2 - C_3$

\[ C_1 \quad \quad \quad C_2 \quad \quad \quad C_3 \]

strict  \quad \quad \quad lax

(higher ranked)  \quad \quad \quad (lower ranked)
3. Theoretical implications for LFG

(adapted from Boersma & Hayes 2001: 47, 49)

- The ranking between $C_2$ and $C_3$ is more prone to the impact of noise.
3. Theoretical implications for LFG

(adapted from Boersma & Hayes 2001: 47, 49)

- Occasionally, $C_3 \gg C_2$
3. Theoretical implications for LFG

Two hypothetical constraints for the syllabic constraint

- $C_1$: penalises 2+1 VPs
- $C_2$: an economy constraint that penalises longer forms, e.g. 2+2 VPs

$C_1 \gg C_2$ in both Mandarin and Wenzhounese
3. Theoretical implications for LFG

<table>
<thead>
<tr>
<th>Mandarin</th>
<th>$C_1 = 53.5$</th>
<th>$C_2 = 50$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2 VP</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>2+1 VP</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

100-trial simulation in R: $C_1 \gg C_2 = 90\%$, $C_2 \gg C_1 = 10\%$

Result of the corpus study: 2+2 VP = 89.8\%, 2+1 VP = 10.2\%

<table>
<thead>
<tr>
<th>Wenzhounese</th>
<th>$C_1 = 50.8$</th>
<th>$C_2 = 50$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2+2 VP</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>2+1 VP</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

100-trial simulation in R: $C_1 \gg C_2 = 70\%$, $C_2 \gg C_1 = 30\%$

Result of the production test: 2+2 VP = 71\%, 2+1 VP = 29\%
3. Theoretical implications for LFG

Q4: Does OT’s domain-general computation undermine LFG’s modularity?

One of the input-output relations in OT-LFG (Mohanan & Mohanan 2003: 313)

\[ \alpha \rightarrow \alpha, \beta, \gamma, ... \]

Constraints from different modules are present in a single computation
3. Theoretical implications for LFG

Category-specific effects in Panoan languages: verbs and non-verbs have different phonological realisations (Elias-Ulloa 2021)

Hypothetical examples (where /C/ stands for an underspecified consonant)

<table>
<thead>
<tr>
<th>Category</th>
<th>UR</th>
<th>SR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verb</td>
<td>/saCa/</td>
<td>[sata]</td>
</tr>
<tr>
<td>Noun</td>
<td>/saCa/</td>
<td>[saka]</td>
</tr>
<tr>
<td>Adjective</td>
<td>/saCa/</td>
<td>[saka]</td>
</tr>
</tbody>
</table>

*t_{VERB}: assign a violation mark to a verb whose /C/ is realised as [t]

(adapted from Elias-Ulloa 2021)
3. Theoretical implications for LFG

Are category-specific effects real?
3. Theoretical implications for LFG

Assume that every markedness constraint is domain-specific, for example:

1. \( ^*t \): Assign a violation mark to a word whose /C/ is realised as [t]

2. \( ^*\text{NEG-V} \): Assign a violation mark to expressions like I eat not, as opposed to 
   
   \( I \text{ don’t eat} \) (adapted from Bresnan 2001: 28)

However these constraints are ranked, there is no interaction between syntax and phonology.
Q4: Does OT’s domain-general computation undermine LFG’s modularity?

No, as long as markedness constraints are domain-specific.
Roadmap

1. Introduction

2. The syllabicity constraint
   - In Mandarin
   - In Wenzhounese

3. Theoretical implications for LFG

4. Conclusion
4. Conclusion

1. 2+1 VPs are less acceptable than 2+2 VPs in Mandarin and Wenzhounese.
2. This syllabicity constraint can be formalised in a modular fashion.
3. The difference between Mandarin and Wenzhounese results from different constraint strength, which challenges binary grammaticality.
4. SOT-LFG can model gradient grammaticality without violating modularity.


4. Bresnan, J. (2001). Explaining morphosyntactic competition. In M. Baltin & C. Collins (Eds.), Handbook of contemporary syntactic theory, 11-44. Blackwell.


Thank you!

Acknowledgement: Many thanks to my supervisor, Dr Louise Mycock, and attendees of the conference previews from our faculty, for their comments. I am also grateful to the Comité International Permanent des Linguistes (CIPL) for the travel grant to attend LFG23.

Chen Xie (DPhil student)
chen.xie@ling-phil.ox.ac.uk
https://users.ox.ac.uk/~kell5077/