How productive is core-periphery structure in the Japanese lexicon?

Empirical results and theoretical implications

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Overview

• **Theoretical background**: Lexical classes and core-periphery structure
  - *Productive* core-periphery structure predicts a **markedness hierarchy**

• Results from a **nonce-loanword nativization experiment** in Japanese
  - **Some—but not all—speakers** show a consistent markedness hierarchy

• Some **theoretical implications**
  - **Faithfulness** relations across lexical strata must be *flexible*
1. Theoretical background and core-periphery structure
(1) What does it mean for the **phonological grammar** when a language has
   - distinct **lexical classes** (strata) with
   - distinct **phonological patterns**?

(2) **Japanese** is a well-known example
   (McCawley 1968; Ito & Mester 1995ab, 1999, 2008; Irwin 2011; etc.)
   - Lexical classes are **phonologically** and **morphologically** distinct
     - Long history of *language contact* and *lexical borrowing*
   - Lexical classes are **psychologically real**
     - *Experiments* show that native speakers are sensitive to phonological differences between classes
       (Moreton & Amano 1999; Gelbart & Kawahara 2007; Tanaka & Fujita 2020)
   - Are the phonological **grammars** of the classes **synchronously** different?
(3) Phonological **contrast** and **restrictions** in constraint-based frameworks

(a) **Restriction** → enforced by **markedness** constraints (M)
   - *predictable* pattern; lack of contrast

(b) **Lack of restriction** → enforced by **faithfulness** constraints (F)
   - *unpredictable* pattern; presence of **contrast**

(4) What does this mean for **lexical classes**?
   - Assuming that phonological differences are **productive**

(a) Suppose some **restriction** is found in lexical class A but not B

(b) We must conclude that **M ≻ F** for A but **F ≻ M** for B
How can we implement this M/F ranking difference across classes?

- Phonological models differ on this point
  → As a result, they make different predictions about the productivity of core-periphery structure

Core-periphery structure

(a) Many languages have phonologically distinct lexical classes (strata) (Mathesius 1934; Fries & Pike 1949; Chomsky & Halle 1968; Postal 1968; Saciuk 1969)

(b) These classes often form a ‘hierarchy of foreignness’ (Kiparsky 1968; Postal 1968; Saciuk 1969; Holden 1976)

(c) Core-periphery structure (Ito & Mester 1995ab, 1999) → The classes form a subset/superset relation in their phonological restrictions
The typical core-periphery pattern:

- **Core**: Phonologically restricted subset of the lexicon | more $M \gg F$
- **Periphery**: Fewer phonological restrictions | more $F \gg M$

Simple example:

- **Core, ‘Native’**
  - **Restriction**: No codas
  - **Restriction**: Only final stress

- ‘Intermediate’
  - **Restriction**: No codas
  - **Contrast**: Non-final stress OK

- **Periphery, ‘Foreign’**
  - **Contrast**: Codas OK
  - **Contrast**: Non-final stress OK
(8) Work pioneered by Ito & Mester (1995ab, 1999) established a key insight:
• **Productive** core-periphery structure → a **hierarchy of M constraints**

(a) **M** prohibiting ‘less foreign’ structures (more **core**) → **low-ranked**
   • Structures that violate them are better **tolerated** in loanwords

(b) **M** prohibiting ‘more foreign’ structures (more **peripheral**) → **high-ranked**
   • Structures that violate them are more aggressively **nativized**

(9) **NoCODA** — enforced in Intermediate Native
• **FINALSTRESS** — enforced in Native only
• **M hierarchy**: **NoCODA » FINALSTRESS**
(10) Different **phonological models** of productive lexical classes make different predictions about the **productivity of core-periphery structure**

(a) **Stratified Faithfulness** (with **Ranking Consistency**)  
(Ito & Mester 1999: 82; see also Fukazawa et al. 1998)

(b) **Weighted Scalar Constraints** (Hsu & Jesney 2017, 2018)

(c) **Cophonologies** (e.g., Inkelas & Zoll 2007)

(d) **New proposal:** **HG Stratified Faithfulness** (Smith 2018)

→ We will return to these models at the end of the talk

• Key point: Given a **M hierarchy** as seen above,  
a phonological model will **enforce core-periphery structure**  
only if the **ranking among F constraints remains the same**  
for all lexical classes
(11) **Empirical test** for productive core-periphery structure:

- It should create **impossible-nativization effects** (Ito & Mester 1999, 2001)

(a) If a core-periphery structure with \( M(no-X) \rightarrow M(no-Y) \) is **productive**...

(b) ...then it should **not** be possible to nativize \( X \) **without** nativizing \( Y \)

(c) Prediction: A form that does this is an **impossible nativization**, rejected or dispreferred by native speakers

- Nativizing stress, not coda \( \rightarrow \) impossible nativization

\[ \text{NoCoda} \rightarrow \text{FinalStress} \]
(12) **Empirical focus** of this project

- Do Japanese speakers show **impossible-nativization effects** for the M constraints that distinguish the lexical classes?
- Preview of results: **Sometimes, but not always!**

(13) **Theoretical implications** of these results

(a) Predictions **too strong** ("grammars must produce IN effects")
   - Stratified Faithfulness *with* Ranking Consistency
   - Weighted Scalar Constraints

(b) Predictions **too weak** ("no reason to expect IN effects")
   - Stratified Faithfulness *without* Ranking Consistency
   - Cogrammars

(c) → **Preliminary support for HG Stratified Faithfulness**
2. Japanese: Productive impossible-nativization effects?
2.1 Japanese lexical classes (strata)
Japanese is a well-known example of a language with a stratified lexicon (e.g., McCawley 1968; Ito & Mester 1995ab, 1999, 2008; Irwin 2011)

- Lexical classes are **phonologically** and **morphologically** distinct
  - Long history of language contact and lexical borrowing
- Lexical classes are **psychologically real**
  - Experiments show that native speakers are sensitive to phonological differences between classes (Moreton & Amano 1999; Gelbart & Kawahara 2007; Tanaka & Fujita 2020)

Do the observed phonological differences between lexical classes correspond to productive impossible-nativization effects?

→ **Nonce-loan nativization experiment** (Smith & Tashiro 2019)
(16) Strata (classes) in the Japanese lexicon

(a) ‘Native’ (N) 和語 — the core
   • Obey the most phonological restrictions

(b) ‘Sino-Japanese’ (SJ) 漢語 — very old loans, starting ca. 500 CE
   • Somewhat less restricted (see Kawahara et al. 2003 on complications)

(c) Recent loans 外来語 — typically from European languages (mostly English) and dating largely from the 19th century (see review in Irwin 2011)
   • The recent loans form a continuum, but less restricted than N, SJ
   • For discussion, useful to distinguish: (Ito & Mester)
     ‘Assimilated Foreign’ (AF) — more nativized
     ‘Unassimilated Foreign’ (UF) — less nativized
M constraints that distinguish strata (after Ito & Mester 1995b)

- **NoSI**: ‘Coronal fricatives are palatal before [i]’
- **NoTI**: ‘Coronal plosives are palatal before [i]’
- **NoDD**: ‘No voiced geminate obstruents’
- **NoP**: ‘No singleton (non-geminate) [p]’
- **NoNT**: ‘No nasal–voiceless obstruent sequences’; Hayes (1999), Pater (2001)

• Formal constraint definitions are in Appendix 2
(18) Observed *enforcement* of M constraints in strata — active alternations (Ito & Mester 1995b, 1999)

- In UF: **NoSI**
- In AF: NoSI and { **NoTI, NoDD** }
- In SJ: NoSI and { NoTI, NoDD } and **NoP**
- In N: NoSI and { NoTI, NoDD } and NoP and **NoNT**

- Relevant examples are in Appendix 2

(19) *Predicted markedness ranking* for Japanese stratified lexicon

**NoSI** » { **NoTI, NoDD** } » **NoP** » **NoNT**

- Follows from (18)
2.2 Nonce-loanword experiment: Materials and methodology
(20) From (19) above:

Predicted markedness ranking for Japanese stratified lexicon (from I&M)

\[ \text{NoSI} \rightarrow \{ \text{NoTI, NoDD} \} \rightarrow \text{NoP} \rightarrow \text{NoNT} \]

- Do speakers show impossible-nativization (IN) effects?
- If so, do those IN effects reflect this ranking?

(21) **Nonce-loanword nativization experiment** — loans from “English”

(a) Methodology based on Guarani nonce-loan experiment (Pinta 2013)

(b) Incorporated audio stimuli as well as orthographic representations

(c) Increased the number of M constraints and the number of participants
(22) **Stimuli — Nonce loanwords**

(a) 5 constraints → all possible pairwise comparisons → **10 constraint pairs**

(b) For each constraint pair, *4 English-like nonce words*

- Each **violates both constraints** in the pair, but no others in (20)
- Loci of violation are in the order $M_i$–$M_j$ twice, $M_j$–$M_i$ twice
- All English “words” are disyllabic with initial stress
- Place is alveolar for all voiced geminates ([dd]) and NT clusters ([nt])

(23) **Example:** Nonce words violating both NoP and NoSI

<table>
<thead>
<tr>
<th>English nonce word</th>
<th>Potential faithful Japanese adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>pimsill</td>
<td>[pɪmˌsɪl]</td>
</tr>
<tr>
<td>polsift</td>
<td>[pɔlˌsɪft]</td>
</tr>
<tr>
<td>sifpem</td>
<td>[sɪfˌpɛm]</td>
</tr>
<tr>
<td>silpesk</td>
<td>[sɪlˌpɛsk]</td>
</tr>
</tbody>
</table>
(24) **Response options** — two-alternative forced-choice task

(a) Each nonce word had two ‘Japanese’ nativization options

(b) Each option satisfies one constraint, violates the other
   
   • Response options were otherwise identical, including pitch accent

(25) Example: Nativization response options for **NoP** versus **NoSI**

<table>
<thead>
<tr>
<th>English nonce word</th>
<th>Satisfies only NoSI: /si/→[ci]</th>
<th>Satisfies only NoP: /p/→[h]</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>pimsill</em></td>
<td>[pimsɪl]</td>
<td>[pimɯciɾɯ]</td>
</tr>
<tr>
<td><em>polsift</em></td>
<td>[pɔlʃɪft]</td>
<td>[porɯciʃwuto]</td>
</tr>
<tr>
<td><em>sifpem</em></td>
<td>[sɪfpeɪm]</td>
<td>[ciʃwipemɯ]</td>
</tr>
<tr>
<td><em>silpesk</em></td>
<td>[sɪlpɛsk]</td>
<td>[ciʃwipesuʃku]</td>
</tr>
</tbody>
</table>
(26) Example screen from experiment

**Survey on Loanwords**

Please listen to the following English word, which we would like to borrow (import as a *katakana* word).
You may listen to the audio as many times as you like.

```
Example loanword: pimsill
```

Which loanword (*katakana word*) is more natural in Japanese?
Please choose the more natural option.

```
Option 1: himusiru
Option 2: pimushiru
```

---

**Transcript**

下の借用（カタカナ語として導入）したい英語の音声を聞いてください。
音声は何度でも聞くことができます。

どちらの借用語（カタカナ語）がより自然な日本語ですか？
より自然な方を選んでください。

- **pimsill**
- **pimushiru**
(27) Stimuli (40 total, + 3 practice) were presented as **audio** and **orthography**

(a) Audio could be replayed by participants
(b) Japanese native-speaker transcribed audio files as an accuracy check
(c) Order of response choices counterbalanced across participants
(d) Sequence of nonce-word stimuli differently randomized each time

(28) Web-based experiment

- Preceded by an audio-check question (using audio? understands Japanese?)
- Followed by a brief questionnaire:
  - demographic information
  - information about participants’ strategies
(29) **Participants: n=40**

(a) Recruited via Facebook and e-mail

(b) Self-reported native speakers of Japanese, raised in Japan, age ≥18

(c) Gender: 26 *female* | 13 *male* | 1 *unspecified*

(d) Age: born in 1959 (*age 58*)–1997 (*age 20*); median 1985 (*age 32*)

(e) Education:

<table>
<thead>
<tr>
<th>high school graduate</th>
<th>tech or jr college grad</th>
<th>in 4-yr univ</th>
<th>4-yr univ graduate</th>
<th>in MA program</th>
<th>MA graduate</th>
<th>in PhD program</th>
<th>PhD graduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>7</td>
<td>17</td>
<td>1</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
2.3 Nonce-loanword experiment: Results and discussion
(30) **Predictions:**
If Japanese speakers have productive core-periphery phonology...

(a) They should show **impossible-nativization effects**
(preferring to **satisfy certain M** over others)

- *Preview:* **Most** speakers have **preferences** for M pairs

(b) They should have a **M hierarchy**
(the ‘backbone’ of the core-periphery structure)

→ The **pairwise M rankings** from the experiment should all fit together into **one consistent M ranking**

- *Preview:* **Some** speakers have a **consistent M ranking**
  
  Some do not
(31) Critical methodology question: How to interpret response patterns?
   • Each constraint pair tested 4 times
   • $C_i$ vs. $C_j$ score could be 4:0, 3:1, 2:2 — when do we say $C_i \gg C_j$?

(32) Response strength, across participants: $C_i$ vs. $C_j$ treated the same way...

<table>
<thead>
<tr>
<th>$4/4$ times</th>
<th>$3/4$ times</th>
<th>$2/4$ times</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>217</td>
<td>118</td>
<td>65</td>
<td>400</td>
</tr>
</tbody>
</table>

(33) Response strength, by participant: $C_i$ vs. $C_j$ treated the same way...
Options for establishing participant constraint rankings from experiment results

(a) **Hand-ranking**: Score 4:0 and 3:1 pairs as ranked, 2:2 pairs as tied. Combine pair rankings into full M hierarchy

*Concern*: Responses are likely to be **probabilistic**, not absolute
→ Can we justify grouping **3:1** with 4:0, rather than with 2:2?
Options for establishing participant constraint rankings from experiment results

(a) **Hand-ranking:** Score 4:0 and 3:1 pairs as **ranked**, 2:2 pairs as **tied**
Combine pair rankings into full M hierarchy

- **Concern:** Responses are likely to be **probabilistic**, not absolute
  → Can we justify grouping **3:1** with 4:0, rather than with 2:2?

(b) **Use the Gradual Learning Algorithm** (Boersma & Hayes 2001) in Praat
Derive a constraint ranking from each participant’s response pattern

- **Concern:** **How far apart** do GLA ranking values need to be for two constraints to qualify as ‘ranked’?
- **Concern:** GLA is **unable to detect** actual ranking **contradictions**
  → A » B, B » C, C » A would merely result in A=B=C for GLA
(35) Strategy: Use a combination of diagnostics

- Run GLA to identify participants with all 5 ranking values close together
- Hand-check those grammars—evidence for contradictory rankings?
(36) **GLA analysis** — have the GLA ‘learn’ each participant’s M grammar

- One Praat *PairDistribution* file representing each participant’s responses
- Example (for one participant):

<table>
<thead>
<tr>
<th>Input</th>
<th>Candidate 1 proportion (satisfies NoSI) — 75%</th>
<th>Candidate 2 proportion (satisfies NoP) — 25%</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>pimsill</em></td>
<td>[pimsɪl]</td>
<td>[pimɯɕiɾɯ]</td>
</tr>
<tr>
<td><em>polsift</em></td>
<td>[pɔlsɪft]</td>
<td>[pɔɾɯɕiɸɯto]</td>
</tr>
<tr>
<td><em>sifpem</em></td>
<td>[sɪfpɛm]</td>
<td>[ɕiɸɯpemɯ]</td>
</tr>
<tr>
<td><em>silpesk</em></td>
<td>[sɪlpɛsk]</td>
<td>[ɕiɾɯpɛsɯkɯ]</td>
</tr>
</tbody>
</table>

- Then, run the GLA (Boersma & Hayes 2001) to model the learning of an OT grammar with that output distribution
(37) Ran 5 learning simulations for each participant

- Each simulation used standard Praat settings for OT learning

Initial ranking value 100.0
38) GLA derives ranking values for all 5 constraints (per participant)

- Still need to determine: How far apart should the ranking values of two constraints be, for those constraints to count as ranked?

39) Find $C_1 > C_2$ probability in outputs, given $C_1 > C_2$ ranking distance ($\text{noise} = 2.0$)
(calculation from Smith & Moreton 2012: §5.2; see also Boersma & Hayes 2001: 49)

<table>
<thead>
<tr>
<th>If $C_1 &gt; C_2$ with distance...</th>
<th>1</th>
<th>1.9</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>4.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of $C_1 &gt; C_2$ in an output is...</td>
<td>0.638</td>
<td>0.749</td>
<td>0.760</td>
<td>0.856</td>
<td>0.921</td>
<td>0.948</td>
</tr>
</tbody>
</table>

What is the criterion for $C_1$ ‘meaningfully dominates’ $C_2$?

(a) **Strict** criterion: Distance $>4.6$, for 95% probability of domination

(b) **Generous** criterion: Distance $>1.9$, for 75% probability of domination
GLA-OT results, **strict** criterion (C1 » C2 95%): Constraints ranked in...

<table>
<thead>
<tr>
<th>Layers</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 5 layers</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) 4 layers</td>
<td>1</td>
<td>S » TD » N » P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) 3 layers</td>
<td>5</td>
<td>S » TDN » P</td>
<td>(4) S » TDN » P</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>S » D » TNP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(d) 2 layers</td>
<td>16</td>
<td></td>
<td>(8) S » TDNP</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(7) STDN » P</td>
<td>STD » NP</td>
<td></td>
</tr>
<tr>
<td>(e) 1 layer</td>
<td>18</td>
<td>undifferentiated</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Overall trend: S » (D » T » N) » P

- P always lowest (or tied)
- S always highest (or tied)
- D » T: 1 / T » D: 0
- T » N: 2 / N » T: 0
- D » N: 3 / N » D: 0
GLA-OT results, **strict** criterion ($C_1 \gg C_2 \, 95\%$; distance $> 4.6$)
(42) GLA-OT results, *generous* criterion ($C_1 \gg C_2 \ 75\%$): Constraints ranked in...

<table>
<thead>
<tr>
<th>Layers</th>
<th>Count</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) 5 layers</td>
<td>3</td>
<td>$S \gg T \gg D \gg N \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg D \gg T \gg N \gg P$</td>
</tr>
<tr>
<td>(b) 4 layers</td>
<td>6</td>
<td>$S \gg TD \gg N \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg D \gg TN \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg D \gg N \gg TP$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg N \gg TD \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$D \gg S \gg TN \gg P$</td>
</tr>
<tr>
<td>(c) 3 layers</td>
<td>14</td>
<td>$S \gg TDN \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg DN \gg TP$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$ST \gg DN \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg N \gg DTP$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$SDN \gg T \gg P$</td>
</tr>
<tr>
<td>(d) 2 layers</td>
<td>9</td>
<td>$STDN \gg P$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$S \gg TDNP$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$SDN \gg TP$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$D \gg STNP$</td>
</tr>
<tr>
<td>(e) 1 layer</td>
<td>8</td>
<td>undifferentiated</td>
</tr>
</tbody>
</table>

Overall trend: $S \gg (D \gg \{T, N\}) \gg P$

- $P$ always lowest (or tied)
- $S$ nearly always highest (or tied)
- $D \gg T$: 10 / $T \gg D$: 3
- $T \gg N$: 6 / $N \gg T$: 6
- $D \gg N$: 9 / $N \gg D$: 2
(43) GLA-OT results, **generous** criterion ($C_1 \gg C_2 \text{ 75\%; distance } > 1.9$)

![Diagram showing GLA-OT ranking values for different participants, categorized by various conditions: NoSI, NoTI, NoDD, NoP, and NoNT. The x-axis represents participants, and the y-axis represents the GLA-OT ranking values.](image-url)
Key question: “Does every participant have a consistent M hierarchy”?

- How deep should the ranking be to count as having a hierarchy?

Summary of ranking results according to the GLA analysis

<table>
<thead>
<tr>
<th>Number of participants</th>
<th>Number of layers in M hierarchy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td>GLA/strict (C1 » C2 95%):</td>
<td>0</td>
</tr>
<tr>
<td>GLA/generous (C1 » C2 75%):</td>
<td>3</td>
</tr>
</tbody>
</table>

More accessible question:
“Do any participants have inconsistent M hierarchies?”

- GLA can’t find this → Examine “suspicious” participants by hand
Participants **likely** to have **inconsistencies** (learned as “ties” by GLA)

- Have **only 1 M layer** even by the generous GLA analysis
- Have a **small number** of 2:2 constraint pairs in experiment ($\leq 3/10$)

- 0 ties: ek74  
  3 . 3 3 . 0 2 2
- 2 ties: nm68, fq02
- 3 ties: hc88, qh64, ij78
(48) Hand-ranked grammars — they all show inconsistent rankings

(a) Number of 2:2 pairs = 0
   • ek74 ▼» NoSI » NoDD » NoP » NoTI »▼ | NoNT inconsistent

(b) Number of 2:2 pairs = 2
   • fq02 ▼=NoSI » NoNT=▼ » NoDD » NoTI »▼ | NoP inconsistent
   • nm68 {NoSI »▼, NoNT=▼} » NoP » NoTI »▼ | NoDD inconsistent

(c) Number of 2:2 pairs = 3
   • hc88 ▼=NoSI » NoNT » NoTI=▼ » NoP=▼ | NoDD inconsistent
   • qh64 ▼=NoSI » {NoTI=▼, NoNT »▼} » NoP | NoDD inconsistent
   • ij78 ▼=NoSI » NoNT » {NoTI=▼, ▼» NoP} | NoDD inconsistent

(49) Typically some constraint “ranked” high and low (often NoDD—!)
    → This collapses the whole hierarchy for GLA
Summary: These six participants each have an M grammar where

- There is **no single consistent ranking**
  - Ranking relationships are **not transitive**

- **Removing just one constraint** leaves a transitive ranking
  - Does this result extend to other participants?
  - Looks promising for the **HG Stratified Faithfulness** model
    → This model allows F constraints to change their relative rankings across strata when necessary
3. Conclusions and implications
Not all participants in the experiment have a consistent M hierarchy

• This might mean...

(a) Lexical strata in Japanese are not productive?

• But this contradicts other results about speaker knowledge of stratal differences

(b) Some speakers have different F rankings across lexical strata

• Some evidence for this from the Mimetic stratum

• This result would have implications for theoretical models of loanword phonology
(52) **Stratified Faith + Ranking Consistency** (Ito & Mester 1999; Fukazawa et al. 1998)

- Designed to model core-periphery structure

(a) Lexical strata have **different M/F rankings** because

  - One M constraint hierarchy
  - **Indexed F constraints** for each lexical stratum

(b) Lexical strata must form a **core-periphery structure**

  - F-internal ranking fixed (by **stipulation**) across strata

→ **Too strong**

  Not all speakers have productive core-periphery phonology
(53) **Weighted Scalar Constraints** *(Hsu & Jesney 2017, 2018)*
- *Designed* to model core-periphery structure, but more simply
  (a) Lexical classes have **different M/F rankings** because
    - One M constraint hierarchy
    - One F constraint hierarchy — no stratum-specific constraints
    - Constraint weights are numerically **scaled**
      - based on the ‘distance’ a form has from the lexical core
  (b) Lexical strata must form a **core-periphery structure**
    - This model **guarantees** consistent F ranking across strata
      - as long as certain restrictions are placed on the scaling factor
    → **Too strong**
      Not all speakers have productive core-periphery phonology
(54) **Cophonologies** (e.g., Inkelas & Zoll 2007)

- *Designed not* to model core-periphery structure

(a) Lexical classes have **different M/F rankings** because

- One M constraint hierarchy
  - One F constraint hierarchy — no stratum-specific constraints

- **Each lexical stratum** has its **own ranking** (cophonology)

(b) No predicted **core-periphery structure**

- Potentially unlimited ranking differences across strata

  -> **Too weak**

Guarani speakers show IN effects in the **absence** of direct evidence from the lexicon or from alternations

(Pinta 2013; Smith & Pinta 2015)
Harmonic Grammar (HG) Stratified Faithfulness (Smith 2018)

- Designed to make core-periphery structure a **default preference, not a requirement** of the grammar

(a) Lexical strata have **different M/F rankings** because

- One M constraint hierarchy
- **Indexed F constraints** for each lexical stratum

(b) **Core-periphery structure** emerges if no evidence to the contrary

- **Cumulative constraint weights** in HG allow general F + stratum-specific F to create **default** consistent ranking effects (as in Jesney & Tessier 2011 for positional F)
- But the F hierarchy can be different across strata, given the appropriate learning data
Next steps in this project:

• Can a **faithfulness** ranking that **differs by stratum** account for the inconsistent M behavior in some experiment participants?
• If so, can the **HG Stratified Faithfulness** model produce the necessary rankings?


Hsu, Brian, & Karen Jesney. 2018. Weighted scalar constraints capture the typology of loanword adaptation. *2017 Annual Meeting on Phonology*.


Appendix 1: Why the StratFaith model needs “Ranking Consistency”

The classic approach: the **OT Stratified Faithfulness** model
(Fukazawa 1997; Fukazawa, Kitahara, & Ota 1998; Ito & Mester 1999b, 2008)

- If a stratified phonological grammar is productive:

  (a) There is a markedness hierarchy $M_1 \succ M_2 \succ M_3 \succ ...$

  (b) Faithfulness constraints are stratum-specific, and are ranked low for core strata and increasingly higher toward the periphery

  (c) F effects “move up” through the M hierarchy in peripheral strata

    $M_1 \succ F\text{-}periph \succ M_2 \succ F\text{-}intermediate \succ M_3 \succ F\text{-}core$

    - Core stratum satisfies $M_1, M_2, M_3$
    - Intermediate stratum satisfies $M_1, M_2$ | $M_3$ can be violated
    - Peripheral stratum satisfies $M_1$ | $M_2, M_3$ can be violated
(58) IN effects and M domination patterns (Ito & Mester 1999, 2001)

(a) In a language with productive stratified phonology, with $M_1 \gg M_2 \gg M_3$

(b) ...there is no stratum where $M_3$ is enforced but $M_2$ is not

(c) For a loan that violates both $M_2$ and $M_3$, a nativization that is *unfaithful* in order to satisfy $M_3$ but still *violates* $M_2$ is predicted to be ungrammatical

• Such a form is therefore called an *impossible nativization*
(59) But!! It turns out that the Stratified Faithfulness model can’t exclude a grammar that allows the ‘impossible nativization’ ranking (Ito & Mester 1999)

- Our schematic example would have:

(60) Markedness constraints

(a) **NoCODA** Assign * for every syllable with a coda (Prince & Smolensky 1993)

(b) **FinalSTRESS** Assign * for every word that does not have stress on the final syllable (ALIGN-R(PrWd, head syll); McCarthy & Prince 1993)

(61) Faithfulness constraints

(a) **MAX** No deletion: Assign * for every input segment that has no output correspondent (McCarthy & Prince 1995)

(b) **StressFAITH** No stress shift; **NoFLOP** (Alderete 1999); **HEADMATCH** (McCarthy 2000)
(62) Markedness/faithfulness rankings for the schematic language nativized?

(a) \text{NoCoda} \rightarrow \text{MaxNative} \quad \text{FinalStress} \rightarrow \text{StressFaithNative} \quad | \quad \text{both}

(b) \text{NoCoda} \rightarrow \text{MaxIntermed} \quad \text{StressFaithIntermed} \rightarrow \text{FinalStress} \quad | \quad \text{only codas}

(c) \text{MaxForeign} \rightarrow \text{NoCoda} \quad \text{StressFaithForeign} \rightarrow \text{FinalStress} \quad | \quad \text{neither}

(63) What it means to have an impossible-nativization effect here:

• There must be no stratum \text{LS} where only stress is nativized
Problem: Even with NoCoda » FinalStress, we can generate this stratum LS MaxLS » NoCoda FinalStress » StressFaith|LS | only stress nativized

- Does not contradict any rankings from (62)
(65) Demonstration of problem: Winner violates NoCODA, satisfies FINALSTRESS

<table>
<thead>
<tr>
<th>/pálti/LS</th>
<th>MAXLS</th>
<th>NOCODA</th>
<th>FINALSTRESS</th>
<th>STRFAITHLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>→ a. pal.tí</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>b. pa.tí</td>
<td>*ₜ</td>
<td>L</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>c. pál.tí</td>
<td>*</td>
<td>*ₜ</td>
<td>*ₜ</td>
<td>L</td>
</tr>
<tr>
<td>d. pá.tí</td>
<td>*ₜ</td>
<td>L</td>
<td>*(w)</td>
<td>L</td>
</tr>
</tbody>
</table>

(66) Conceptually, the solution is to ensure that there can be no stratum LS with the ranking MAXLS » STRESSFAITHLS
(67) **Ranking Consistency** (Ito & Mester 1999: 82; see also Fukazawa et al. 1998)

- Let F and G be two types of IO-faithfulness constraints [MAX, STRESSFAITH].
- Then the relative rankings of the indexed versions of F and G are the same across all strata: \( \forall AB (F_A \succ G_A) \Rightarrow (F_B \succ G_B) \)
Appendix 2: Constraint definitions and stratum-specific alternations

(after Ito & Mester 1995b)

(68) NoNT Assign one * for every sequence of [+nasal] [-voice] ('No nasal–voiceless obstruent sequences'); Hayes (1999), Pater (2001)

- Satisfied in N; violations found in SJ, AF, UF
  
  (a) Constraint satisfied (I&M 1999: 68)

  \[
  /\text{sin} + \text{ta}/_{\text{NAT}} \text{'die-PAST'} \rightarrow \text{[cinda]}
  \]

  
  (b) Violations tolerated (I&M 1999: 69)

  \[
  \text{computer} \quad [\text{kəmpjutə}] \rightarrow [\text{kompjuwtaa}]
  \]

  
  \[
  /\text{hum} + \text{kir-\text{u}}/_{\text{NAT}} \text{'step-cut-NONPAST'} \rightarrow [\text{fumgiru}] \quad \text{Santa} \quad [\text{sæntə}] \rightarrow [\text{santa}]
  \]

  ‘make up one’s mind’
(69) NoP Assign one * for every singleton (non-geminate) [p]

- Satisfied in N, SJ; violations found in AF, UF
  
  (a) **Constraint satisfied** (I&M 1999: 67,75)  
  
  \[\text{p\text{an}}\text{}/\text{SJ} \text{‘group’;  } \rightarrow [\text{h\text{an}}]; \text{   } \text{cf. } /\text{i\text{t+p\text{an}}}\text{/ ‘group one’  } \rightarrow [\text{ip\text{pan}}] \text{   } \text{cf. } /\text{i\text{ppan}}\text{/ ‘bread’} \text{   } [\text{p\text{ao}}] \rightarrow [\text{pan}]\text{  }\text{(<Portuguese)}\]

  (b) **Violations tolerated** (I&M 1999: 74,75)

  \[\text{ja(p)p\text{ari}/\text{NAT ‘after all’} \rightarrow [j\text{app\text{ari}}]} \text{   } \text{cf. } [\text{jah\text{ari}}]\text{  }\text{pet} \rightarrow [\text{pet}] \rightarrow [\text{petto}]\]
(70) NoDD  Assign one * for every voiced geminate obstruent

• Satisfied in N, SJ, AF; violations found in UF

  (a) Constraint satisfied (I&M 1999: 67)  (b) Violations tolerated (I&M 1995b: 819)

/ow+dɔs+ɯ/_{NAT} → [ondasɯ]  dog  [dɔg] → [dɔggɯ]
‘chase-put.out-NONPAST’;  ‘drive out’;

cf. /ow+kake+rɯ/_{NAT}  cf. [okkakeru]
‘chase-run-NONPAST’  ‘run after’

bag  [bæg] → [bakkkɯ]  bed  [bɛd] → [beddɔ]
(71) **NoTI**

Assign one * for every sequence of \([\text{COR}, -\text{son}, -\text{cont}]\) [i]

('Coronal plosives are palatal before [i]')

- Ito & Mester's (1995b) NoTI (*TI) penalizes all coronal obstruents + [i]

- Satisfied in N, SJ, AF; violations found in UF
  
  (a) **Constraint satisfied** (I&M 1995b: 828)  
      
  \[
  \begin{array}{ll}
  \text{team} & [\text{tim}] \rightarrow [\text{tɕiimɯ}] \\
  \text{ticket} & [\text{tikət}] \rightarrow [\text{tɕiiketto}] \\
  \text{teen} & [\text{tin}] \rightarrow [\text{tiiN}] \\
  \text{party} & [\text{pɑ(ɹ)ti}] \rightarrow [\text{paa+tii}] \\
  \end{array}
  \]
(72) NoSI  Assign one * for every sequence of [\text{COR}, -son, +cont] [i]
(‘Coronal fricatives are palatal before [i]’)

• Satisfied in nearly all forms, including UF

\begin{align*}
\text{cinema} & \quad [\text{sinəmə}] \rightarrow [\text{ɕinema}] & \text{Citibank} & \quad [\text{sitibæŋk}] \rightarrow [\text{ɕitibaŋkɯ}] \sim ?[\text{ɕitibaŋkɯ}] \\
\text{dressing} & \quad [\text{dɹɛsin}] \rightarrow [\text{doɾɛɕiŋɯ}] & \text{season} & \quad [\text{siːzən}] \rightarrow [\text{ɕiːzɯn}] \sim [\text{ɕiːzɯn}] \\
& & & \quad (\text{sports commentators})
\end{align*}

• Ito & Mester (1999: 77) and Irwin (2011: 84) observe that potential violations of NoSI in even very recent loans are nearly always nativized
(73) Confirm: Ranking values per participant **consistent**?

- Two groups: low vs. high *ranking-value spread per* constraint across the 5 runs
- Low vs. high spread reflects *range* of ranking values *across* constraints

Range 2.72–8.08, *low* max spread ≤0.106 | Range ≥13.45, *high* max spread 0.326–1.18

Re: generous ‘domination’ criterion: Only 3 participants had max spread > 0.85 (interval >1.9)
### Appendix 4: Hand-ranked grammars

(74) Hand-ranked grammar for participant **ek74** (number of 2:2 pairs = 0)

<table>
<thead>
<tr>
<th>Grammar 1</th>
<th>Grammar 2</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoSI » NoTI/4</td>
<td>NoSI » NoDD/4</td>
<td>NoSI » NoP/3</td>
</tr>
<tr>
<td>NoDD » NoTI/3</td>
<td>NoP » NoTI/3</td>
<td>NoTI » NoNT/3</td>
</tr>
<tr>
<td>NoDD » NoP/4</td>
<td>NoDD » NoNT/3</td>
<td>NoNT » NoP/4</td>
</tr>
</tbody>
</table>

- **Consistent:** NoSI » NoDD » NoP » NoTI
- **NoNT** inconsistent:
  - High? NoNT » NoSI (and NoNT » NoP)
  - Low? NoTI » NoNT (and NoDD » NoNT)
Hand-ranked grammar for participant **fq02** (number of 2:2 pairs = 2)

- **Consistent:**  
  - NoSI → NoNT → NoDD → NoTI

- **NoP inconsistent:**  
  - High?  
    - NoSI = NoP (and NoP = NoNT)
  
  - Low?  
    - NoTI → NoP (and NoDD → NoP)
(76) Hand-ranked grammar for participant **nm68** (number of 2:2 pairs = 2)

<table>
<thead>
<tr>
<th>Rule</th>
<th>Equivalent</th>
</tr>
</thead>
<tbody>
<tr>
<td>NoSI » NoTI/3</td>
<td>NoSI » NoDD/3</td>
</tr>
<tr>
<td>NoTI » NoDD/3</td>
<td>NoP » NoTI/3</td>
</tr>
<tr>
<td>NoDD » NoP/3</td>
<td>NoDD=NoNT/2</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Consistent (with tie):** \{NoSI, NoNT\} » NoP » NoTI
- **NoDD inconsistent:**
  - **High?** NoDD=NoNT and NoDD » NoP
  - **Low?** NoTI » NoDD (and NoSI » NoDD)
Hand-ranked grammar for participant **hc88** (number of 2:2 pairs = 3)

\[
\begin{align*}
\text{NoSI} & \Rightarrow \text{NoTI/3} & \text{NoSI} = \text{NoDD} & \text{NoSI} & \Rightarrow \text{NoP/3} & \text{NoSI} & \Rightarrow \text{NoNT/3} \\
\text{NoTI} = \text{NoDD} & & \text{NoTI} & \Rightarrow \text{NoP/4} & \text{NoNT} & \Rightarrow \text{NoTI/4} \\
\text{NoDD} = \text{NoP} & & \text{NoNT} & \Rightarrow \text{NoDD/4} & & \text{NoNT} & \Rightarrow \text{NoP/4}
\end{align*}
\]

- Consistent: \text{NoSI} \Rightarrow \text{NoNT} \Rightarrow \text{NoTI} \Rightarrow \text{NoP}
- \text{NoDD} inconsistent: - High? \text{NoSI} = \text{NoDD} \ (\text{and} \ \text{NoTI} = \text{NoDD})
  - Low? \text{NoDD} = \text{NoP} \ (\text{and} \ \text{NoNT} \Rightarrow \text{NoDD})
Hand-ranked grammar for participant **qh64** (number of 2:2 pairs = 3)

- **NoSI** » **NoTI/4**  
  - **NoSI** = **NoDD**  
  - **NoTI** = **NoDD**  

- **NoSI** » **NoP/4**  
  - **NoSI** » **NoNT/3**

- **NoTI** = **NoDD**  
  - **NoTI** » **NoP/3**

- **NoDD** » **NoP/3**

- **NoNT** » **NoDD/3**

- **NoNT** » **NoP/3**

---

- **Consistent (with tie):**  
  - **NoSI** » { **NoTI, NoNT** } » **NoP**

- **NoDD** inconsistent:  
  - **High?**  
    - **NoSI** = **NoDD** (and **NoTI** = **NoDD**)  
  - **Low?**  
    - **NoNT** » **NoDD**
(79) Hand-ranked grammar for participant **ij78** (number of 2:2 pairs = 3)

\[ \text{NoSI} \rightarrow \text{NoTI/4} \quad \text{NoSI} = \text{NoDD} \quad \text{NoSI} \rightarrow \text{NoP/4} \quad \text{NoSI} \rightarrow \text{NoNT/3} \]

\[ \text{NoTI} = \text{NoDD} \quad \text{NoTI} = \text{NoP} \quad \text{NoNT} \rightarrow \text{NoTI/3} \]

\[ \text{NoDD} \rightarrow \text{NoP/3} \quad \text{NoDD} \rightarrow \text{NoNT/4} \]

\[ \text{NoNT} \rightarrow \text{NoP/3} \]

- **Consistent (with tie):**  \( \text{NoSI} \rightarrow \text{NoNT} \rightarrow \{ \text{NoTI, NoP} \} \)
- **NoDD inconsistent:**
  - **High?**  \( \text{NoSI} = \text{NoDD} \) (and \( \text{NoDD} \rightarrow \text{NoNT} \))
  - **Low?**  \( \text{NoTI} = \text{NoDD} \)