Aging and Age-Independent Effects of Cognitive and Sociolinguistic Backgrounds:

On the Strength of Tonal Systematic Correspondence by Tonal Bilinguals

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Age-related differences are observed in speech production. Speakers of the same generation and the same age still vary in their speech performance. The interaction of different factors remains unclear.
Systematic Correspondence in Tonal Bilingualism

- Most Jinan speakers are bilinguals of Jinan Mandarin (JM) and Standard Chinese (SC).
- Translation equivalents of JM and SC often share the segmental composition, but differ in tone.
- The tones of most different translation equivalents are controlled by systematic correspondence rules.

- E.g. Within the monosyllabic SC words carrying high-level tones, 81% have JM translation equivalents carrying low-rising tones.
Systematic Correspondence in Tonal Bilingualism

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<table>
<thead>
<tr>
<th>BM (SC)</th>
<th>Tone 1: high-level</th>
<th>Tone 2: high-rising</th>
<th>Tone 3: low-rising or dipping</th>
<th>Tone 4: high-falling</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>JM</td>
<td>81% (low-)rising</td>
<td>76% high-falling</td>
<td>70% high-level</td>
<td>75% low-falling</td>
<td>76%</td>
</tr>
</tbody>
</table>
Systematic Correspondence in Tonal Bilingualism

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<table>
<thead>
<tr>
<th>SC</th>
<th>JM</th>
</tr>
</thead>
<tbody>
<tr>
<td>“know” /hl+f/</td>
<td>“know” /r+lf/</td>
</tr>
<tr>
<td>“need” /hl+f/</td>
<td>“need” /r+lf/</td>
</tr>
<tr>
<td>“opportunity” /hl+f/</td>
<td>“opportunity” /r+lf/</td>
</tr>
</tbody>
</table>
Systematic Correspondence in Tonal Bilingualism

- The strength of tonal systematic correspondence varies across the bilinguals.
Research Questions:

- How do cognitive and sociolinguistic backgrounds affect the strength of tonal systematic correspondence?

- Which cognitive and sociolinguistic backgrounds have age-independent effects and which do not?
Predictions

- The pitch distance between two JM words is more likely to be smaller if their counterparts share tonal categories in SC.
- The strength of systematic correspondence in JM word production decreases with the increase in age.
  - Socio.: Older bilinguals are more JM dominant and less proficient in SC
  - Cog.: Older bilinguals have cognitive aging
- Age independent effects?
The Word Naming Corpus

- 42 Jinan native bilingual speakers named 400 disyllabic written words presented on a computer screen.
- Named words were recorded.
- Pitch contours of the rhymes of the words were extracted with Praat.
- Production errors, contour outliers, and naming-latency outliers were excluded.
Measurements of Individual Backgrounds

- All speakers except one received formal education, of which 57% reached college level and the rest reached middle school level. As for the literacy education, 26% speakers received it in JM, 56% received it in SC, and 18% received it in a combination of JM and SC.
- The other measurements are distributed as follows.
Measurements of Individual Backgrounds

Figure 1.
Modeling Method

- Multi-linear regression models were built including between-word pitch distance of JM words (Euclidean distance) as the dependent variable and linguistic, cognitive, and sociolinguistic backgrounds as the predictors.
- Explorative statistics: backward elimination.
- Collinearity elimination: residualization & stratification.
Analysis and Results

- Analysis 1: Individual Models
- Analysis 2: Individual backgrounds separately
- Analysis 3: Residualized Models
- Analysis 4: Stratified Models
Analysis 1: Individual Models

- Models without individual backgrounds.
- The sharing of tones between two SC words is related to a smaller between-word pitch distance of their translation equivalents in JM, revealing the systematic correspondence mechanism.

![Graph showing estimated mean distance for different tonal relations in SC]

Tonal relation in SC: [neither (nn), only the first (yn), only the 2nd (ny), both (yy) syllable(s) are from the same tonal category].
Analysis 2: Individual backgrounds separately

- Each aspect of the individual backgrounds included separately in smaller models.
- Each mediated and unmediated effect investigated together.
- The strength of systematic correspondence generally decreased with the increase of age.
- Other cognitive and social backgrounds mainly showed effects mediated by age effect.

**Older bilinguals tend to have**

- slower digit naming speed,
- smaller auditory working memory, and
- poorer tonal awareness, as well as
- higher JM proficiency and frequency,
- lower education level, and
- received literacy education in JM.
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- The strength of systematic correspondence generally decreased with the increase of age.
- Other cognitive and social backgrounds mainly showed effects mediated by age effect.
Analysis 3: Residualized Models

- Only the frequency of JM usage still had an unmediated effect; a higher freq. reducing the effect of systematic correspondence.
- Age effect interacts with the type of literacy education.
Analysis 3: Residualized Models

When neither is identical to its SC counterpart

Residualized JM frequency interacts with SC tonal relation

Residualized JM proficiency interacts with education level

Literacy education in JM

Literacy education in SC

Literacy education in mixing language
Analysis 4: Stratified Models

• Younger speakers tend to receive a higher education and receive literacy education in SC. This type of collinearity was not considered in the model mentioned above.

• Age-independent cognitive effects emerged in the middle-age bilinguals.

• Young bilinguals only showed age-independent frequency effect
Analysis 4: Stratified Models

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AWM: auditory working memory
Analysis 4: Stratified Models

- Young bilinguals only showed age-independent frequency effect
Discussion & Conclusion

- The strength of tonal systematic correspondence by tonal bilinguals is influenced by language change and cognitive aging.
- Literacy education is very important.
- Age-independent cognitive skills only affect the middle-aged bilinguals.
Acknowledgements

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