Exploring the role of rhythm in iterative-infixing language game learning

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Introduction

- Present results of a language game learning experiment on iterative-infixing games
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- Results suggest that games with a certain type of repeating rhythmic pattern may be easier to learn
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This may suggest that the rhythmic pattern is a strategy for reducing the cognitive burden of processing disguised words, or even that the provides a frame outside of which iterative infixation can’t be processed
Background

What is an iterative-infixing language game?
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Subclass of **infixing** language games (Pound 1964, Bagemihl 1988)
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Infix is applied **iteratively** within a single source word, usually once per source syllable.
Background

Löfflisch - an iterative-infixing language game based on German

1https://www.youtube.com/watch?v=Vq7P8dgNQTo
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Löflisch - an iterative-infixing language game based on German\(^1\)

- Infixation of [-ləv-]
- Source: game syllable correspondence = 1:3
- Extra vowel generated by copying source nucleus

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Besuch
[bɛzuχ]

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Iterative-infixing language games tend to feature **iterative rhythm** patterns.
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In Löflisch, source syllables correspond to surface anapests:

\[
[b\varepsilon.'zu\chi] \rightarrow [b\varepsilon.l\varepsilon.vu.l\varepsilon.'vux]
\]
Background

Previous studies have suggested that iterative rhythm may be a key defining feature of iterative-infixing language games:

Yu (2007, 2008) gives a grammar of IILGs where the output rhythm pattern is the highest-ranked constraint; vowel copying and epenthesis are repair strategies for satisfying the constraint. Yu further notes that iterative infixation in language games appears to correlate with a reduction of phonological complexity, and that iterative-infixing language game outputs often carry less contrastive information than their source counterparts.
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It may be the case that iterative infixation is only possible with the support of a rhythmic frame; perhaps iterative infixation patterns that cannot be given a rhythmic analysis are not learnable.
Question

Where does iterative rhythm come from?
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Why are there no iterative-infixing language games that lack iterative rhythm? That is, why do we only see games where iterative infixation can be given a rhythmic analysis, instead of, e.g., a game where the infix appears every 5th syllable? (Pound 1964, Yu 2007, 2008)
Hypotheses

**Epiphenomenal rhythm**: Iterative rhythm is a coincidental factor of the pathways of language game creation.

**Grammar-external factors**: Games with iterative rhythm are easier to learn and use and so are more robust diachronically.
Experiment

Experimental question:

When speakers learn a game whose grammar is already fixed, does iterative rhythm facilitate the learning process?
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If so, grammar-external factors must play a role in determining the ease of learning.
Experiment

- Language game learning experiment
- Subjects learned one of two language games, one with iterative rhythm and one without
## Experiment

### Predictions:

<table>
<thead>
<tr>
<th>Rhythm type</th>
<th>Epiphenomenal</th>
<th>Grammar-external</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhythmic</td>
<td>Equal difficulty</td>
<td>Easier</td>
</tr>
<tr>
<td>Arrhythmic</td>
<td>Equal difficulty</td>
<td>Harder</td>
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</table>
Condition 1: Rhythmic
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mid source vowel → infixation of [-ləv-] and vowel copying
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mid source vowel $\rightarrow$ infixation of [ləv-] and vowel copying

high source vowel $\rightarrow$ infixation of [ləv-] and epenthesis of [ə]

mo mi $\rightarrow$ mo ləv o mi ləv ə
Experiment

Condition 2: Arrhythmic
Experiment

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mid source vowel $\rightarrow$ infixation of [-ləv-] and vowel copying
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mid source vowel $\rightarrow$ infixation of [-ləv-] and vowel copying

high source vowel $\rightarrow$ infixation of [-ləv-] but no third syllable
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Rhythmic game features constant 1:3 source:game syllable correspondence
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Arrhythmic game alternates between 1:2 and 1:3 correspondence depending on source vowel height
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ə-epenthesis in Rhythmic game intended to control for difficulty of vowel-height based alternation in Arrhythmic game without compromising iterative rhythm
Experiment

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Training phase: source item played, immediately followed by corresponding language game item

Test phase: source item played, followed by possible language game item; subjects classified second item as correct or incorrect game version of first item
Experiment

Stimuli:

- Composed of recordings of CV syllables
- Recorded by male and female speakers; speaker gender randomized across items
- Normalized for pitch, intensity, and vowel duration; falling intonation added to word-final syllables
- Syllables spliced together on demand by Psychopy software
- Source words consisted of one, two, or three syllables
- All possible combinations of mid/high source vowels represented
Experiment

Stimuli:

50% of test items were the correct game version of the source word for the game the subject was learning.
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“Correctness” category was randomized by item, except that “wrong game” could not be assigned to a word with all mid vowels because the two games have identical outputs.
Participants:

- 18 native English speakers (12 male, 6 female)
- Mean age: 22.7 (min. 18, max. 29, SD=3.4)
- Participated for course credit or received $10 for completing this and four other short tasks
- 2 subjects (1 male, 1 female) excluded from analysis for failing to learn a preliminary sample game. 1 subject (female) was excluded from analysis for inattentiveness.
- Analysis includes 8 subjects in the Arrhythmic condition and 7 subjects in the Rhythmic condition.
Results

Figure 1: Accuracy by subject, by condition and phase
Results

Rhythmic condition subjects seem to have performed slightly better.

4 out of 7 Rhythmic subjects passed the first test phase, and none had to continue beyond the second phase.

1 out of 8 Arrhythmic subjects passed the first test phase, and 3 had to continue to the third phase.

Upshot: Qualitatively, it looks like it takes more practice to learn the Arrhythmic game.
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Analysis

Logistic mixed effects regression model

- Interaction: condition, training
- Main effects: condition, training, gender
- Random effects: subject, item

Summary:

| Estimate | Std. Error | z value | Pr(>|z|) |
|----------|------------|---------|----------|
| (Intercept) 0.68278 | 0.55846 | 1.223 | 0.2215 |
| ConditionRhythmic -0.89830 | 0.77295 | -1.162 | 0.2452 |
| Training 0.02752 | 0.01366 | 2.015 | 0.0439 * |
| SexMale -0.21259 | 0.42650 | -0.498 | 0.6182 |
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Significant main effect of training ($p=0.0439<0.05$): unsurprising that training helps subjects perform better.
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**Significant interaction between training and condition** ($p=0.0433<0.05$): amount that training affects performance depends on condition.
Analysis

Visualizing the significant interaction:

Figure 2: Predicted log odds of correct response vs. training, by condition
The direction of the significant interaction suggests that the Rhythmic game is more readily learned than the Arrhythmic game.
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This constitutes preliminary evidence that iterative-infixing language games with iterative rhythm are easier to learn than those without.
Discussion

The results support the **grammar-external factors** hypotheses, which suggests that performance factors play a role in the diachronic proliferation of games with iterative rhythm.
Conclusion

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This would suggest that the typological skew in favor of iterative rhythm is due at least in part to a grammar-external bias toward iterative rhythm - maybe to the extent iterative infixation without an iterative rhythmic frame can’t be learned.

Of course, there might still be grammar-internal factors that also make iterative-infixing language games more likely to arise in the first place.
Future work

**Confirmation of effect:** Can the current findings be replicated?
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**Production**: Do subjects learn to correctly produce forms in a rhythmic game faster than in an arrhythmic game?
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**Production:** Do subjects learn to correctly produce forms in a rhythmic game faster than in an arrhythmic game?

**Perception of real words:** Is it actually the case that iterative rhythm makes it easier to recover source segments from a stream of disguised speech?
References


