Memory and handedness effects on phonological judgments

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Overview

- Factors affecting phonological judgments
  - Phonotactic probability
  - Neighborhood density
- Attempts to distinguish them in Mandarin
  - Interaction with working memory constraints
  - Interaction with brain lateralization
    - Handedness (and gender)
    - Visual field of stimulus display

Phonological judgments

- Non-speeded reports of a "sensation"
  - Acceptability: Naturalness and/or typicality
- Multidimensional, like all linguistic behavior
  Behavior = *f*("Grammar", "Processing")
- Major influences on phonological judgments
  Judgment = *f*(**Phonotactics** + **Neighborhoods**)
  Grammar? Naturalness? *Processing? Typicality?*
- Challenge
  - Can these factors be distinguished?

Phonotactic probability

- Analytical and prelexical
  - More like lexicon-independent "grammar"
- One formal definition (e.g., Bailey & Hahn, 2001)
  - Geometric mean of Prob($phone_i$ | $phone_{i-1}$)
- Examples in Mandarin

/nun^3/	.093
/lan^1/	.175
/p^{h}un^2/	.231
/tan^2/	.346

(Based on morpheme [character] type frequencies)

(Tone conditioned off onset)

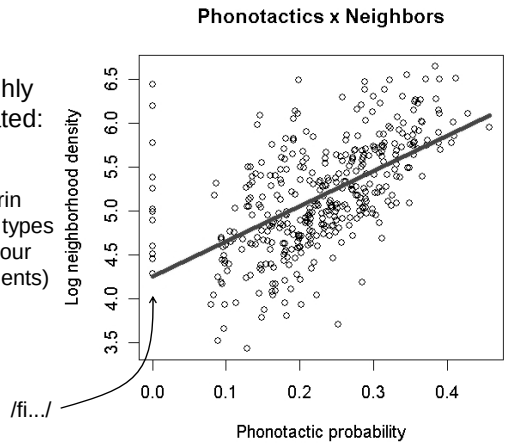
Neighborhood density

- Holistic and postlexical
  - More like exemplar-driven "analogy"
- One formal definition (e.g., Luce, 1986)
  - Number of words differing from target by one phone (via deletion, insertion, or substitution)
- Examples in Mandarin

/nun^3/	66	[low phon, low neigh]
/lan^1/	272	[low phon, high neigh]
/p^{h}un^2/	136	[high phon, low neigh]
/tan^2/	346	[high phon, high neigh]

These factors are highly correlated:

(Mandarin syllable types used in our experiments)



Teasing them apart

- Effect of lexical status (Vitevitch & Luce, 1999)
  - In naming tasks, phonotactics help nonwords, while neighbors hurt words
- Effect of task (Vitevitch & Luce, 1999)
  - Neighbors hurt lexical decision for both types
- Effect of age (Newman & German, 2005)
  - Phonotactics consistent, neighbors vary
- Neurological correlates (Stockall et al., 2004)
  - Sensitivity to phonotactics is left-lateralized and prior to lexical frequency and neighbors

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Caveats

- Many ways to define both (Bailey & Hahn, 2001)
- They interact (Luce & Large, 2001)
- Judgment task effects:
  - Phon & Neigh both help (Bailey & Hahn, 2001)
  - Nonwords only vs. mixed (Shademan, 2007)
  - Measurement scale?
    - Binary vs. ordinal vs. continuous-valued…
- Cross-language differences...?
  - English (above) vs. Cantonese (Kirby & Yu, 2007) vs. Mandarin (Myers & Tsay, 2005)

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Mandarin stimuli

p p^h m f t t^h n l	×	a i u @	×	n ng #	×	Tone1 Tone2 Tone3 Tone4	=	384

- 235 lexical, 149 nonlexical
- Displayed in the phonetic notation used in Taiwan: ㄋㄨㄥˇ ㄌㄢˊ ㄆㄨˇ ㄌㄧˋ

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Overall experimental logic

- Speakers asked to judge if “like Mandarin”
- Lexical and nonlexical items mixed
- Factorial design, including covariates
- Nonlexical analysis:
  (Phonotactics + Neighbors) x Other factors
- Lexical analysis:
  (Phono + Neigh + Freq) x Other factors
- **Key:** Do phonotactics and neighbors show different kinds of interactions…?

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Memory effects

- Overall logic
  - Do neighbors influence via lexical activation?
  - If so, strength of neighbor effect should depend on working memory capacity
  - Phonotactics shouldn’t be affected
- Varying working memory capacity
  (e.g., Vos et al., 2001; Saucier & Elias, 2002)
  - Individual differences (recall accuracy test)
  - Experimental manipulation of memory load

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Memory experiment: Design

- Procedure
  - Syllables judged in blocks
  - Test syllable(s) presented prior to each block
    - Low load: 1 syllable; High load: 3 syllables
  - Recall tested after each block
    - Recall accuracy measured for each participant
- Judgment scale
  - Ordinal 1-6, rescaled to 0-1, then arcsine transformed (after Bailey & Hahn, 2001)
- Analysis:

  Recall acc. x Mem. load x (Phon+Neigh+[Freq])

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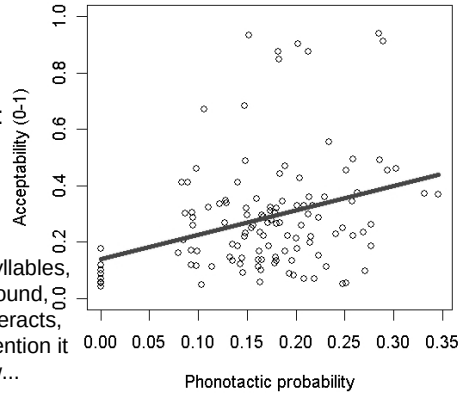
Memory experiment — Nonlexical syllables

Nonlexical

Effect of phonotactics:

It helps

In nonlexical syllables, this is always found, and it never interacts, so we won't mention it anymore below...



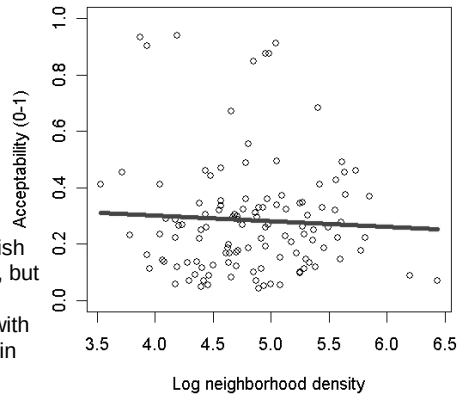
Memory experiment — Nonlexical syllables

Nonlexical

Effect of neighbors:

Nothing...?

... unlike English or Cantonese, but like our other experiments with these Mandarin items…

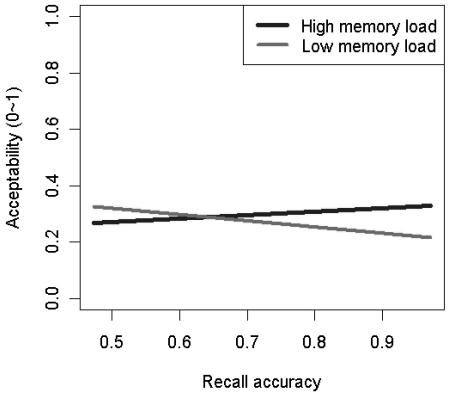


Memory experiment — Nonlexical syllables

Nonlexical

Effect of memory:

They trade off ... ??



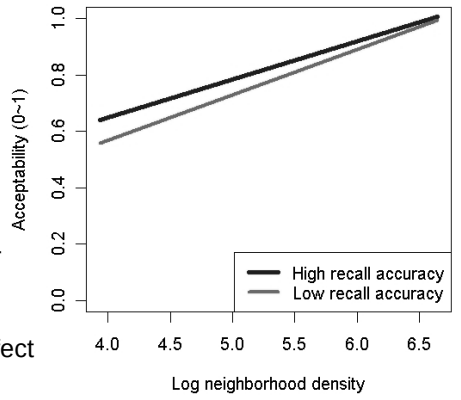
Memory experiment — Lexical syllables

Lexical

Neighbors x Recall accuracy:

Both help...

... but better memory weakens neighbor effect



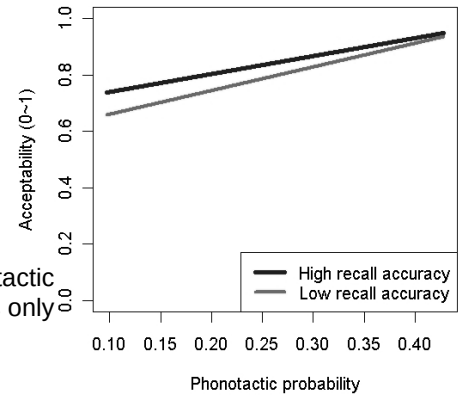
Memory experiment — Lexical syllables

Lexical

Phonotactics x Recall accuracy:

Same interaction...

... but phonotactic effect itself is only marginal



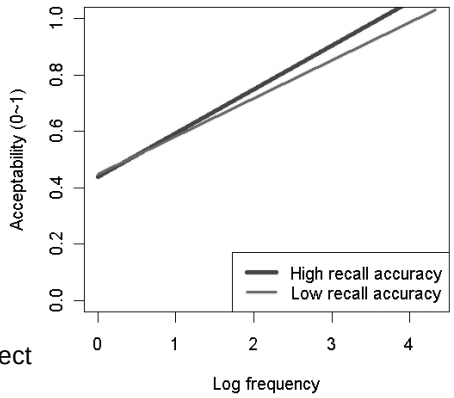
Memory experiment

Lexical

Frequency x Recall accuracy:

Both help...

... but better memory *enhances* frequency effect



Memory experiment: Summary

- Lexical status
  - Nonlexical: No neighborhood effect
  - Lexical: Weak phonotactic effect
    - Exaggerated by high proportion of real syllables...?
- Memory loading didn't do much
- Recall accuracy effects for lexical items
  - Better memory weakens both Phon & Neigh
  - Better memory strengthens frequency effect
  - Strategy: Just try to look up word in memory

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Handedness effects

- Overall logic
  - Phonotactics uses special phonology processor?
  - Phonology is left-lateralized
    - Especially for right-handers (e.g., Knecht et al., 2000)
    - And males? (e.g., Shaywitz et al., 1995)
  - Left-handers (females?) have back-up in right...?
- Predictions
  - Phonotactics x Handedness x Gender:
    - Lefties and women will show strongest effect...?
  - Neighbors won't depend on these factors

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Handedness experiment: Design

- Participants
  - Right- and left-handed men and women
    - "Corrected" lefties excluded
- Judgment scale
  - Magnitude estimation (Stevens, 1956)
- Analysis

  Handedness x Gender x (Phon + Neigh + [Freq])
- Quick results...
  - Nonlexical: Main effect of phonotactics only
  - Lexical: Effects only of frequency...

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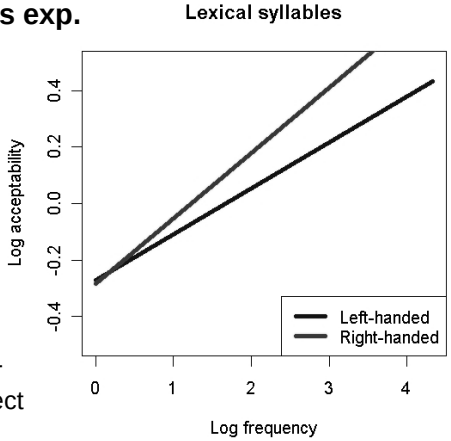
Handedness exp.

Lexical

Frequency x Handedness:

Main effect only of frequency...

... but righties show stronger frequency effect

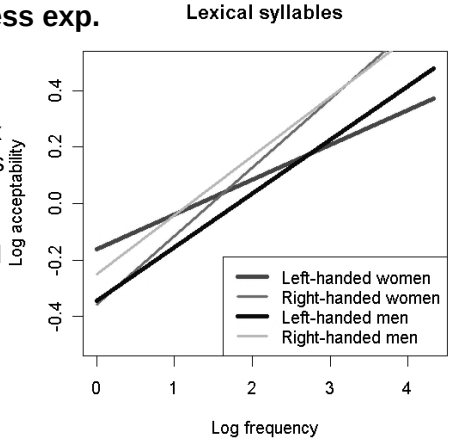


Handedness exp.

Lexical

Frequency x Handedness x Gender:

Freq x Hand interaction restricted to women



Handedness exp.

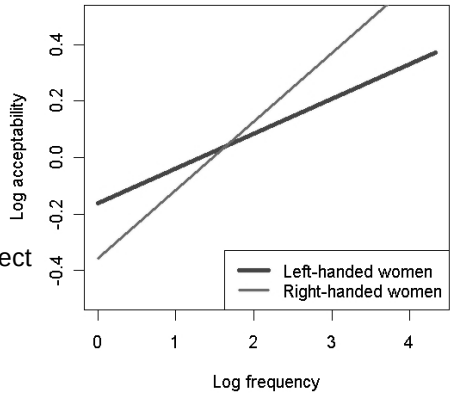
Lexical syllables

Lexical

Frequency x Handedness:

Women only

Stronger frequency effect in righties



Handedness exp.

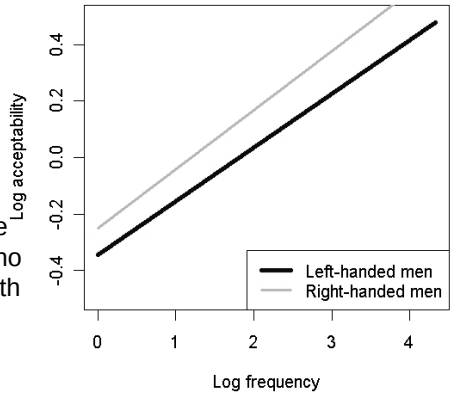
Lexical syllables

Lexical

Frequency x Handedness:

Men only

Righties more positive, but no interaction with frequency



Handedness experiment: Summary

- Phonotactics and neighbors...
  - Nothing! Maybe due to magnitude estimation?
    - Recent criticism (Featherston, 2008)
- Handedness, gender, and frequency
  - Strongest frequency effect in righty women
- Possible interpretation
  - Strategy: Just look up word in memory
  - Word access involves left lateralization...
  - ... and men tend to be more left lateralized regardless of handedness...?

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Visual field effects

- Overall logic
  - In righties, phonotactics is left-lateralized...?
  - Stimuli in right visual field (RVF) goes quicker (more efficiently) to left hemisphere
    - Caveat: RVF & attention (e.g., Brysbaert et al., 1996)
- Predictions
  - Stimuli in RVF will elicit stronger phonotactic effect than in LVF
  - No influence on neighbor effect...?

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Visual field experiment: Design

- Participants
  - Natural righties only, both men and women
- Procedure
  - Fixate on center of screen
  - Syllables flashed left/right (130 ms, 30 ms mask)
  - Quick good/bad judgment (mean RT = 684 ms)
- Analysis

  Vis. field x Gender x (Phon + Neigh + [Freq])
- Quick results...
  - Nonlexical: Only phonotactics, as usual...
  - Lexical: Frequency helps, and...

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Visual field exp.

Lexical syllables

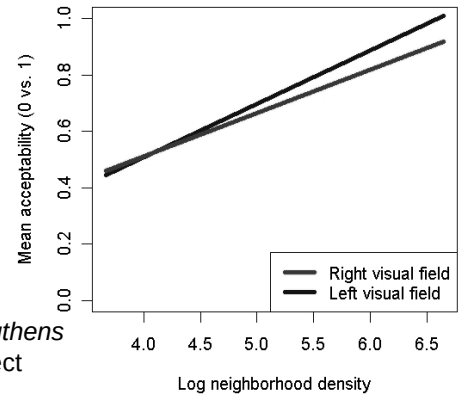
Lexical

Neighbors x Visual field:

Neighbors help...

Left visual field helps...

... and *strengthens* neighbor effect



Visual field experiment: Summary

- Lexical status effects dominate as usual
- Neighbor effect stronger in LVF
  - Neighbor effect in right hemisphere…?
- Why?
  - Because it's holistic...? (e.g. Koivisto & Laine, 1999)
  - ... but earliest MEG component sensitive to neighbors is left-lateralized (Stockall et al., 2004)

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Conclusions*

- Phonotactic probability
  - Used prelexically (found with nonlexical items)
  - But not obligatory in lexical items...?
    - Weaker effects, especially if memory is good
- Neighborhood density
  - Used postlexically (stronger in lexical items)
  - Right-lateralized...?
- Judgments of lexical syllables in Mandarin
  - Depends mainly on frequency (memory)
  - Left-lateralized (esp. right-handed women...?)

*(highly tentative!)

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