PREVIOUS EXPERIENCE CONSTRAINS ADAPTATION: PHONOTACTICS AND SPEAKER LANGUAGE BACKGROUND

Thomas Denby and Matt Goldrick
Northwestern University

9/16/17

Research Supported by NSF Ling-DDRI grant #1728173

Phonotactics

- Constraints on sound sequences within syllables and words

- Constraints vary between languages
  - e.g. English: [sʌŋ] but *[ŋʌs]
  - Vietnamese [ŋũ] (“sleep”)

- Variation in phonotactic constraints not characteristic of individual talkers (Pierrehumbert, 2001)

Phonotactic adaptation

- In experimental settings, listeners quickly learn novel constraints (e.g. “syllables cannot end in voiceless stops”)
- Listeners make more false memory errors for syllables that follow, rather than violate, experimental constraint (Denby, et al, in press)
- Adaptation effects also appear in speech errors (Dell, et al, 2000) and repetition times (Onishi, Chambers, and Fisher, 2002)

Big question

How does our prior experience with phonotactic variation constrain adaptation to novel phonotactics?

Big question

How does our prior experience with phonotactic variation constrain adaptation to novel phonotactics?

Hypothesis

Listeners adapt to systematic variation while ignoring irrelevant variation using their prior experience

Big question

How does our prior experience with phonotactic variation constrain adaptation to novel phonotactics?

Hypothesis

Listeners adapt to systematic variation while ignoring irrelevant variation using their prior experience

- E.g. variation in consonant production due to individual variation/dialect vs. speaker with disrupted production due to pen in mouth (Kraljic, Samuel, & Brennan, 2008)

Big question

How does our prior experience with phonotactic variation constrain adaptation to novel phonotactics?

Hypothesis

Listeners adapt to systematic variation while ignoring irrelevant variation using their prior experience

- Prior experience ➔ systematic phonotactic variation between speakers of *different languages*, little variation between speakers of the same language/dialect

Big question

How does our prior experience with phonotactic variation constrain adaptation to novel phonotactics?

Predictions

- Talker-specific phonotactic constraints (e.g. 2 speakers of English) ➔ lower degree of adaptation
- Language-specific constraints (1 English speaker vs. 1 French speaker) ➔ greater degree of adaptation

Recognition Memory Task

- Listeners hear a series of nonsense syllables without breaks
- No explicit information about talkers included
- Prompt: “Have you heard this sound before?”
- After stimulus plays: respond “YES” or “NO”

- Listeners asked to track nonsense syllables in memory
- Can probe learnability of constraints (Bernard, 2015, 2017; Steele, et al., 2015; Denby et al., in press)

Recognition Memory

"No fricatives in coda; stops unrestricted"

- Phase I: Familiarization
  - Expose listeners to repeated instances following constraint

pak, sut, kut, ʃap, kut, pak, tap…

Recognition Memory

"No fricatives in coda; stops unrestricted"

- Phase II: Generalization
  - Expose listeners to occasional **novel** generalization syllable

*tap, sut, pak, **puk**, kut, **tus**, ʃap…*

Recognition Memory

"No fricatives in coda; stops unrestricted"

- Phase II: Generalization
  - Expose listeners to occasional **novel** generalization syllable

*tap, sut, pak, **puk**, kut, **tus**, ʃap…*

  - Legal (follows constraint) or illegal (violates constraint)

Do participants incorrectly respond "yes" more often on legal syllables?

Experiment Overview

- English listeners exposed to talker-specific constraints
  - E.g. “Speaker A does not end their syllables in fricatives; speaker B doesn’t end their syllables in stops”

- Experiment 1
  - Preregistered with Open Science Foundation
  - Number of participants set to maximize power ($\beta = .804$)
    - Determined by Monte Carlo simulations based on results from pilot study

- Experiment 2
  - Follow-up study

Experiment 1 Overview

- English listeners exposed to talker-specific constraints
  - 4 conditions


	Native Shared	***Non-Native Shared***	***Weak Different***	***Strong Different***
Language Background	Shared English	Shared French	English vs. French	English vs. French
French vs. English vowels	[i, u] [i, u]	[i, y] [i, y]	[i, u] [i, u]	[i, y] [i, u]

Experiment 1 Overview

- English listeners exposed to talker-specific constraints
  - 4 conditions

	Native Shared	***Non-Native Shared***	***Weak Different***	***Strong Different***
Language Background	Shared English	Shared French	English vs. French	English vs. French
French vs. English vowels	[i, u] [i, u]	[i, y] [i, y]	[i, u] [i, u]	[i, y] [i, u]
Control: Gender	Different	Different	Same	Same

Methods

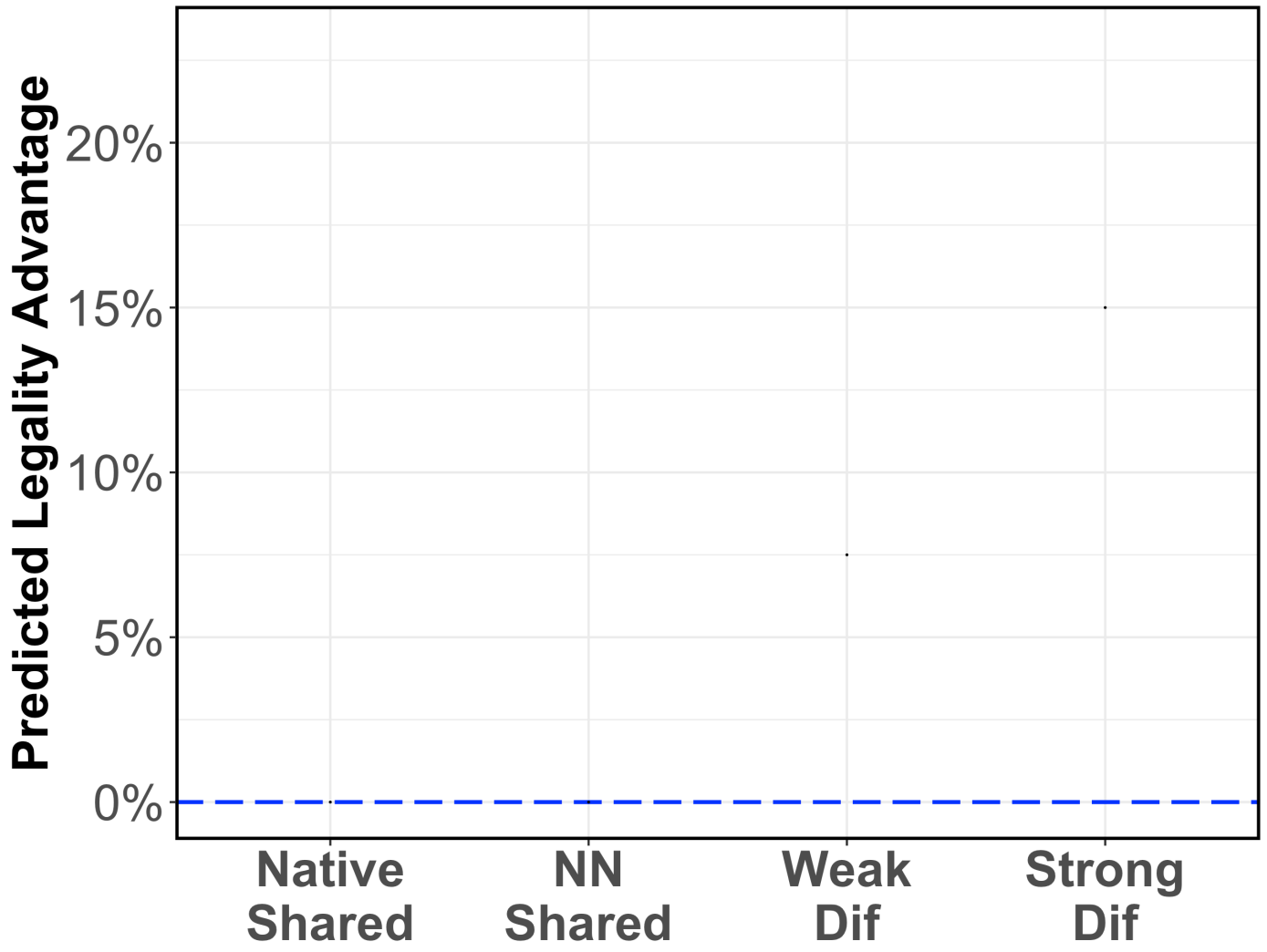
- 64 participants/condition (AMT; passed criteria for attending to task)
- Stimuli
  - 72 CVC nonsense syllables
  - 6 onsets [s,ʃ,f,t,k,p] * 2 vowels [i,u/y] * 6 codas
  - One speaker ends syllables in fricatives; other speaker in stops (counter-balanced)
- Procedure
  - Familiarization: 4 reps of 36 syllables
  - Generalization: 9 more reps of familiarization syllables, intermixed with 36 novel generalization syllables (4/block)
  - 504 continuous trials

Generalization syllables following familiarization pattern are ***legal***, those that don't are ***illegal***

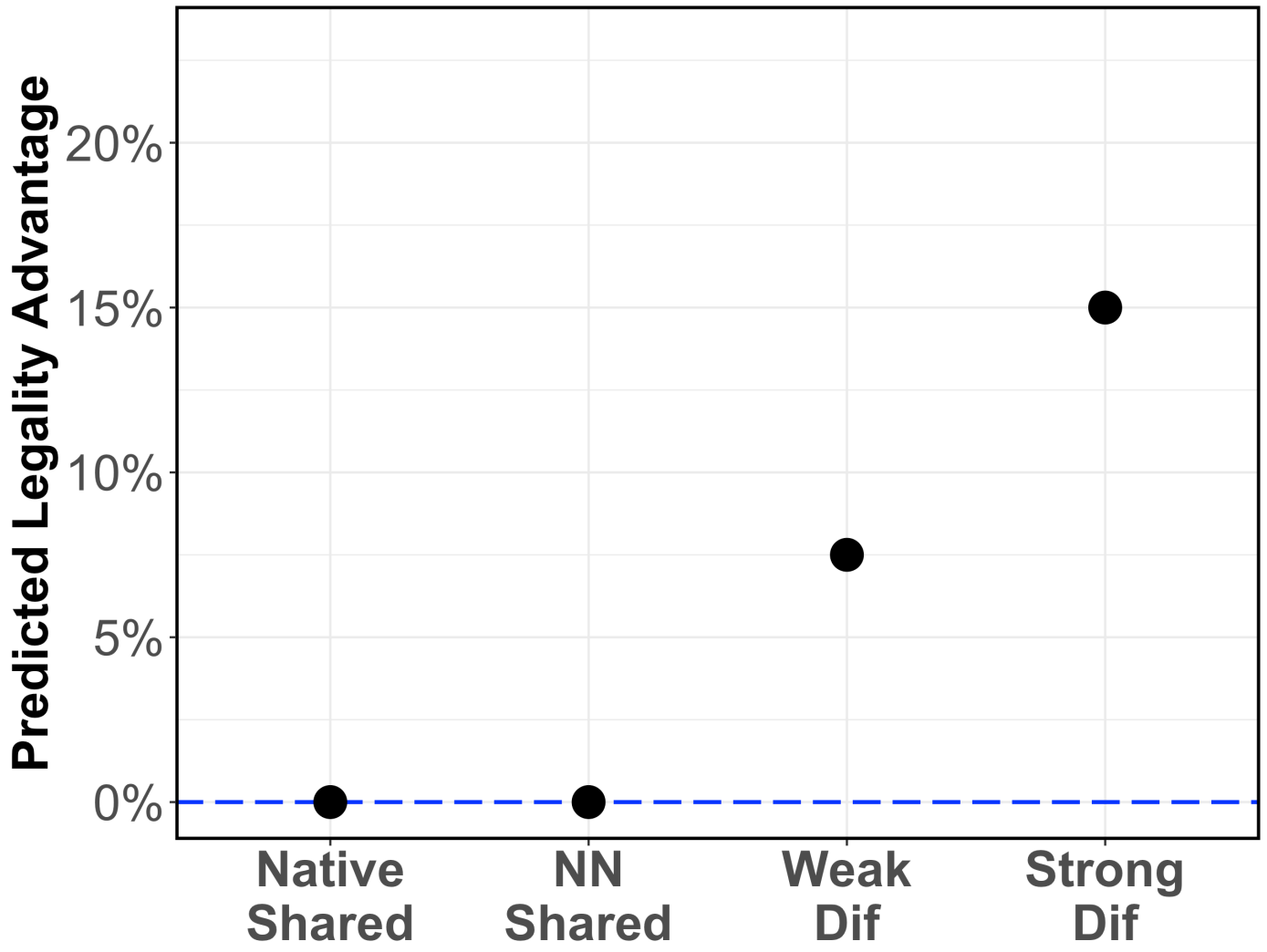
	Speaker A: Fricative codas	**Speaker B: Stop Codas**
Familiarization	fu**f**, ki**ʃ**, ti**s**, **ʃ**u**f**	fu**t**, ki**p**, ti**k**, **ʃ**u**k**
Generalization - ***legal***	fi**f**, ku**ʃ**, fi**t**, ku**p**	
Generalization - ***illegal***	tu**s**, tu**f**, tu**k**, shi**p**	

Adaptation: More false alarms on legal vs. illegal

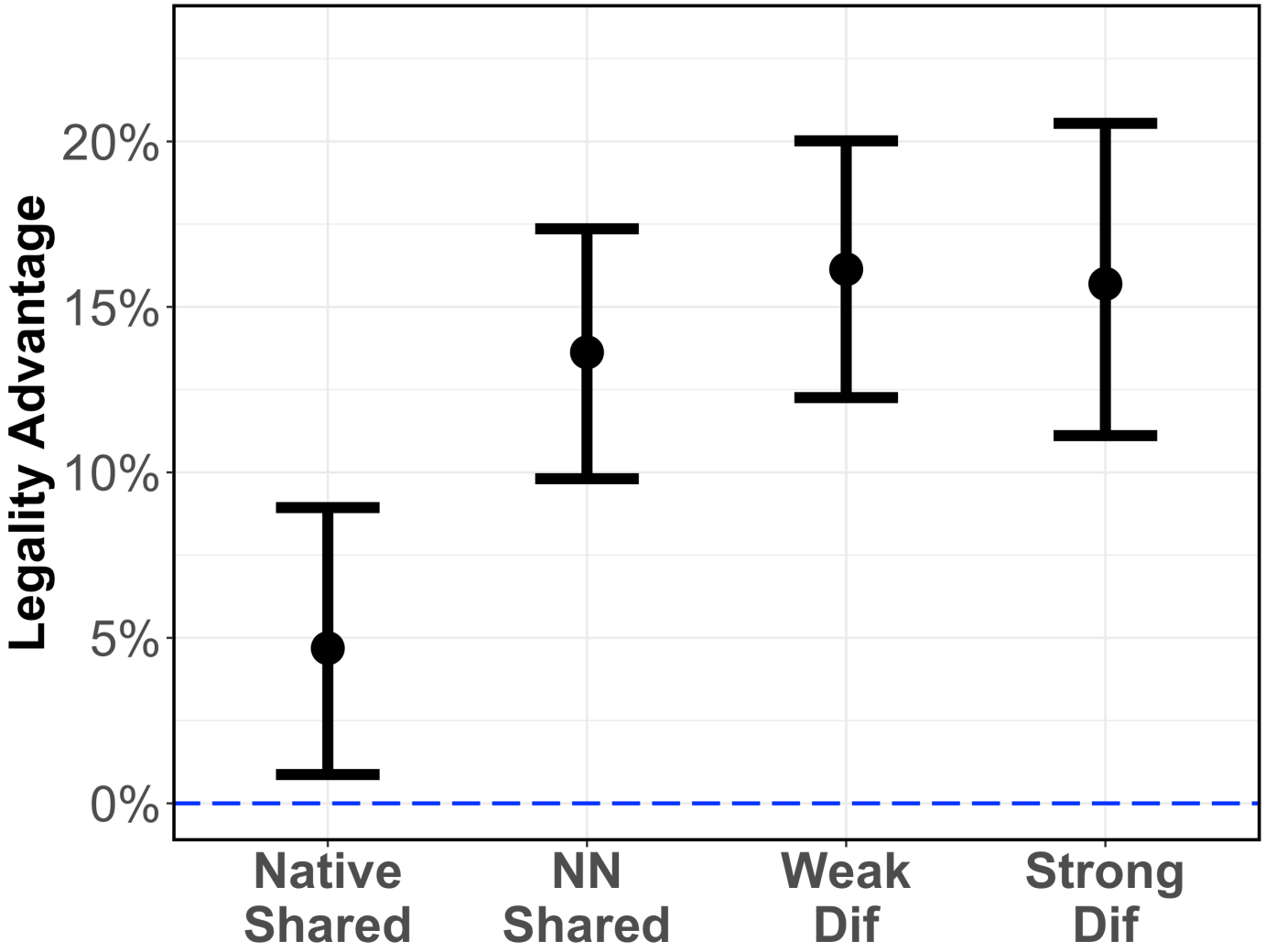
Experiment 1 predicted results



Experiment 1 predicted results



Experiment 1 results



Experiment 1 limitations

1. Familiarization and generalization syllables did not always match
   - All generalization syllables had [i] or [u] (never [y])
   - ➢ *May have inhibited adaptation in Strong Different condition*

2. French talkers were phonetically dissimilar
   - Different pitch contours across male and female French speakers
   - Female speaker had not recently been in French-dominant environment
   - ➢ *Listeners may have inferred multiple language backgrounds in "NN shared" condition*

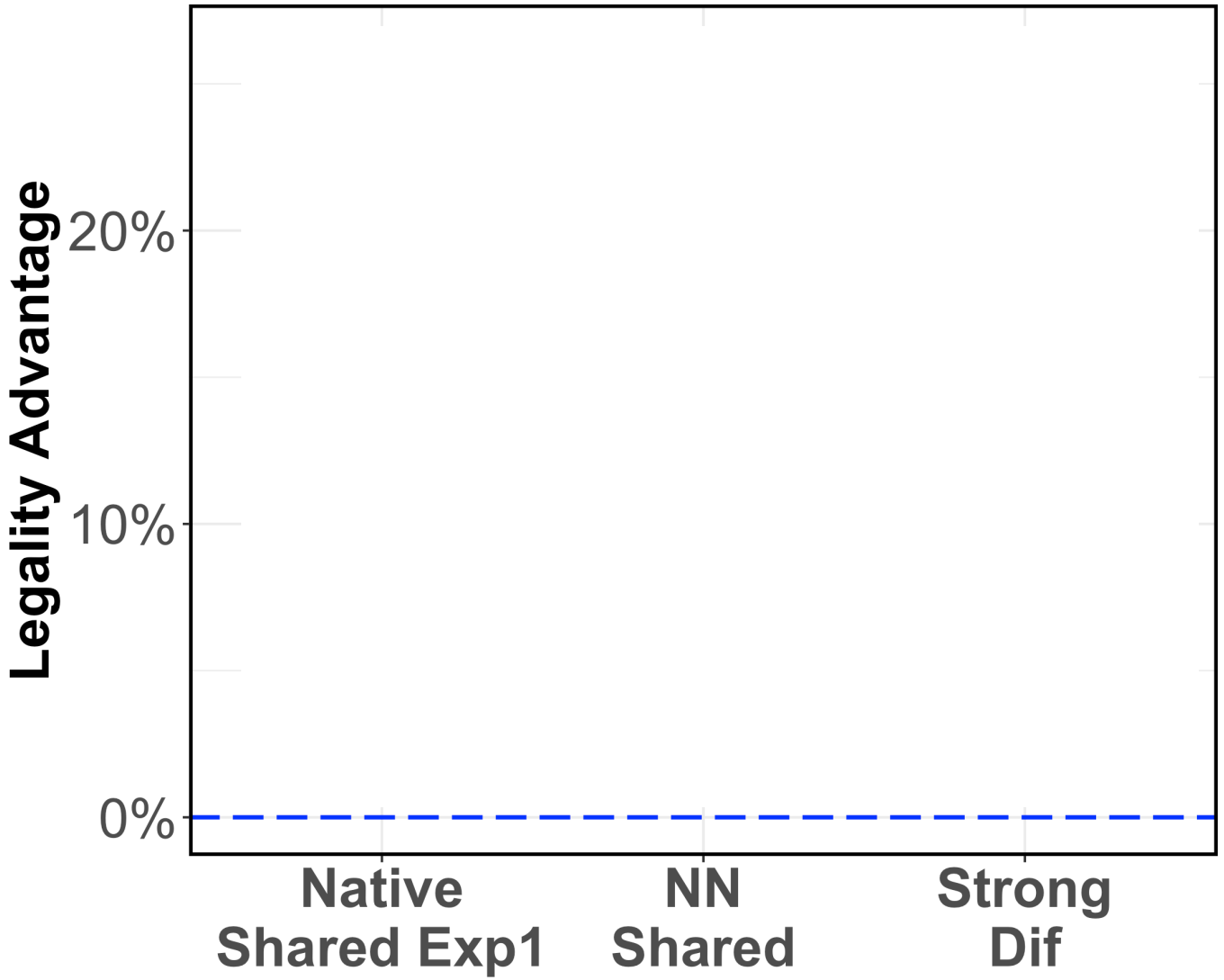
Experiment 2

- *NN shared* and *Strong different* conditions
- Generalization syllables match familiarization ([y] instead of [u])
- Recorded novel French female speaker
  - Imitated French male speaker's utterances

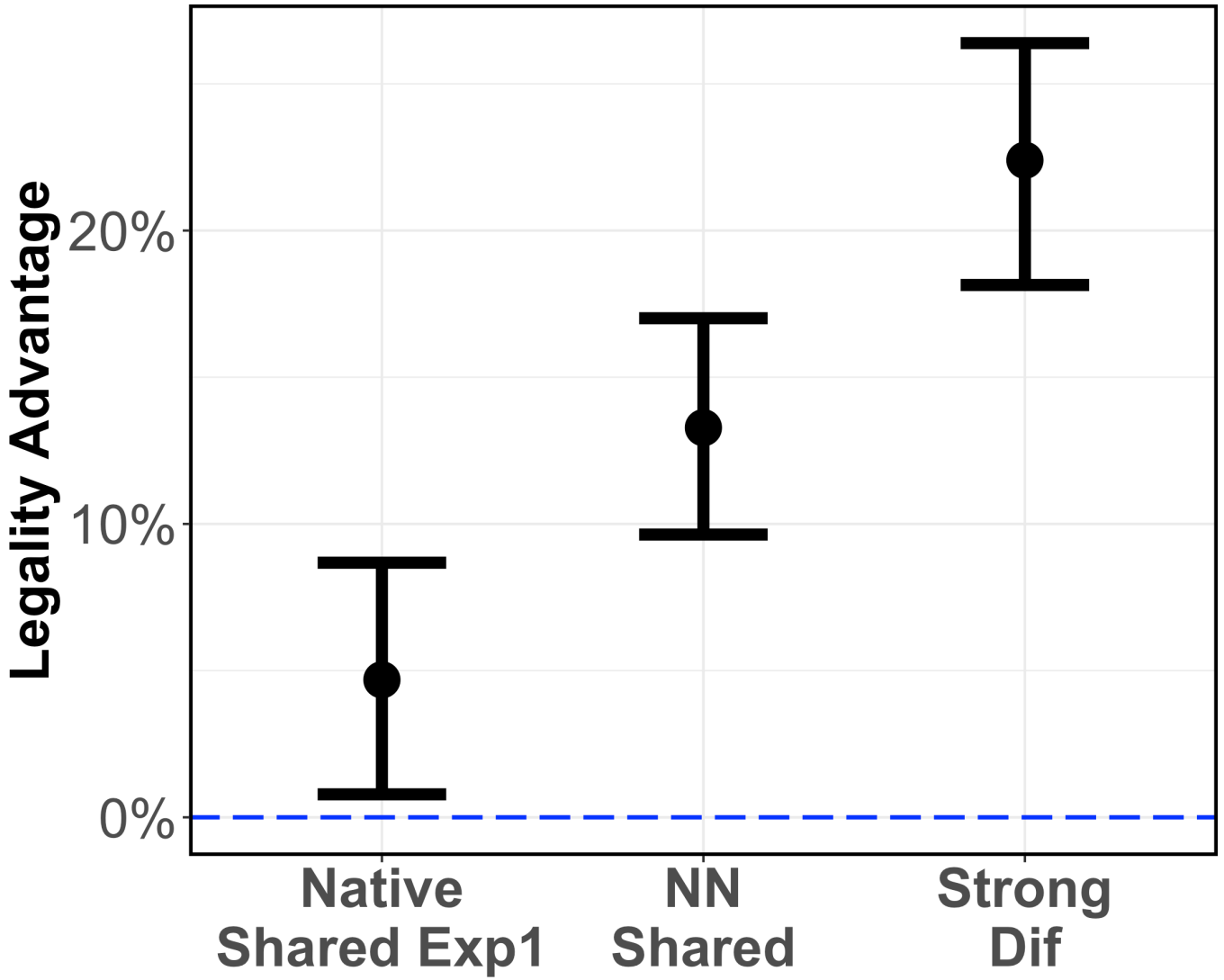
Experiment 1

Experiment 2

Experiment 2 results



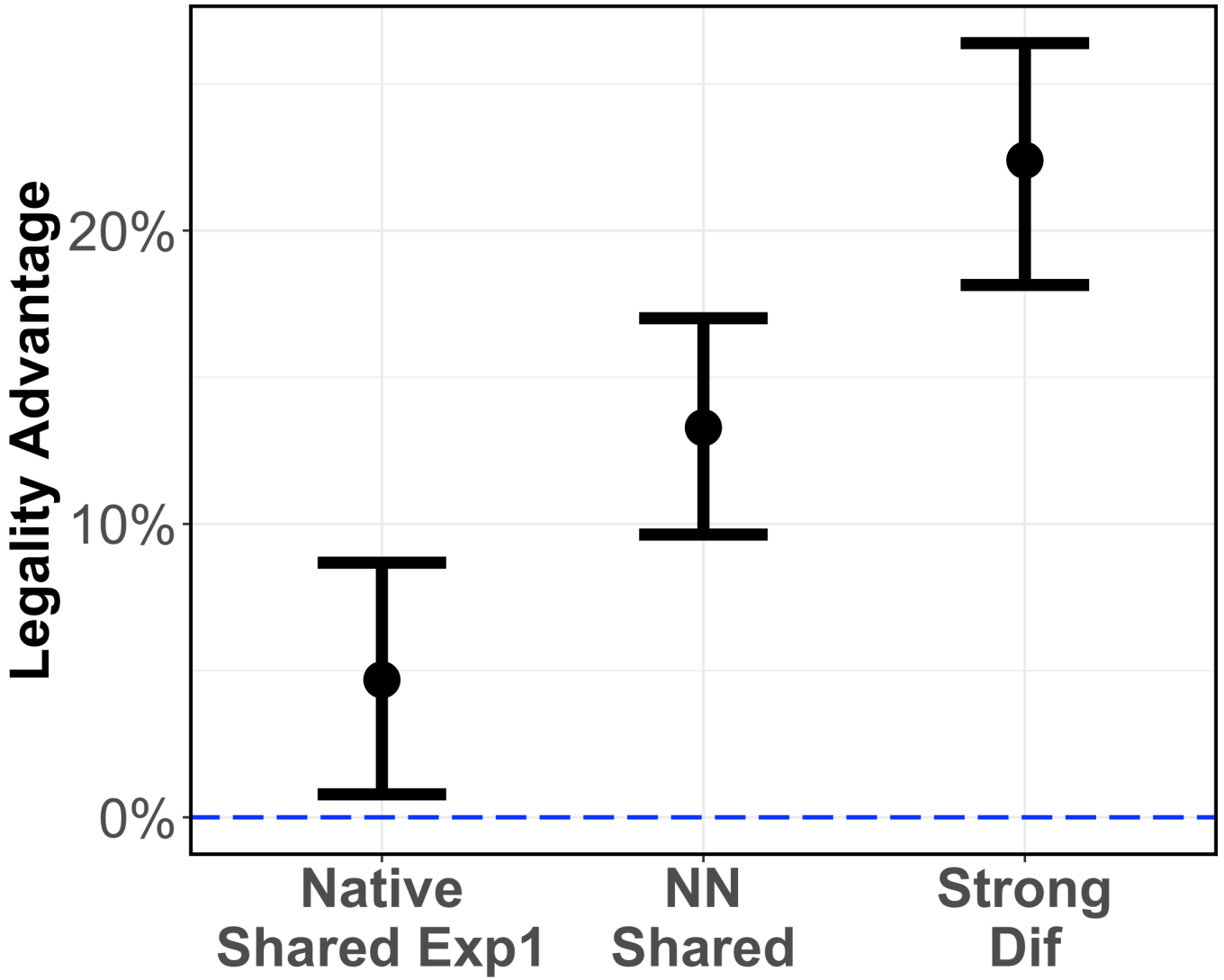
Experiment 2 results



Experiment 2 results

Strong > NN shared > Native shared

Both presence of NN speech + language differences ➔ adaptation



Summary

Hypothesis

Listeners adapt to systematic variation while ignoring irrelevant variation using their prior experience

- Listeners show largest degree of adaptation to talker-specific constraints when talkers differ in language background
  - Future work will investigate if listeners are sensitive to differences between non-native languages

Summary

Hypothesis

Listeners adapt to systematic variation while ignoring irrelevant variation using their prior experience

- Additionally, listeners show moderate adaptation when talkers share a non-native language background
  - Presence of non-native speakers may increase listener confidence that talkers do not share a language background
  - Future work will manipulate strength of non-native language background cues within NN Shared condition

Conclusion

Phonotactic adaptation is constrained by previous experience

- Not simply associative pattern learning (Anderson, Holmes, & Dell, 2016)
- Informed by previous linguistic experience (e.g., Pajak, et al., 2016)

Thank you!

Thanks to the NSF for their generous funding,

and to Jennifer Cole, Ann Bradlow, Melissa Baese-Berk, Chun Chan, and the NU SoundLab for their help and feedback!

tdenby [at] u.northwestern.edu

sites.northwestern.edu/denby

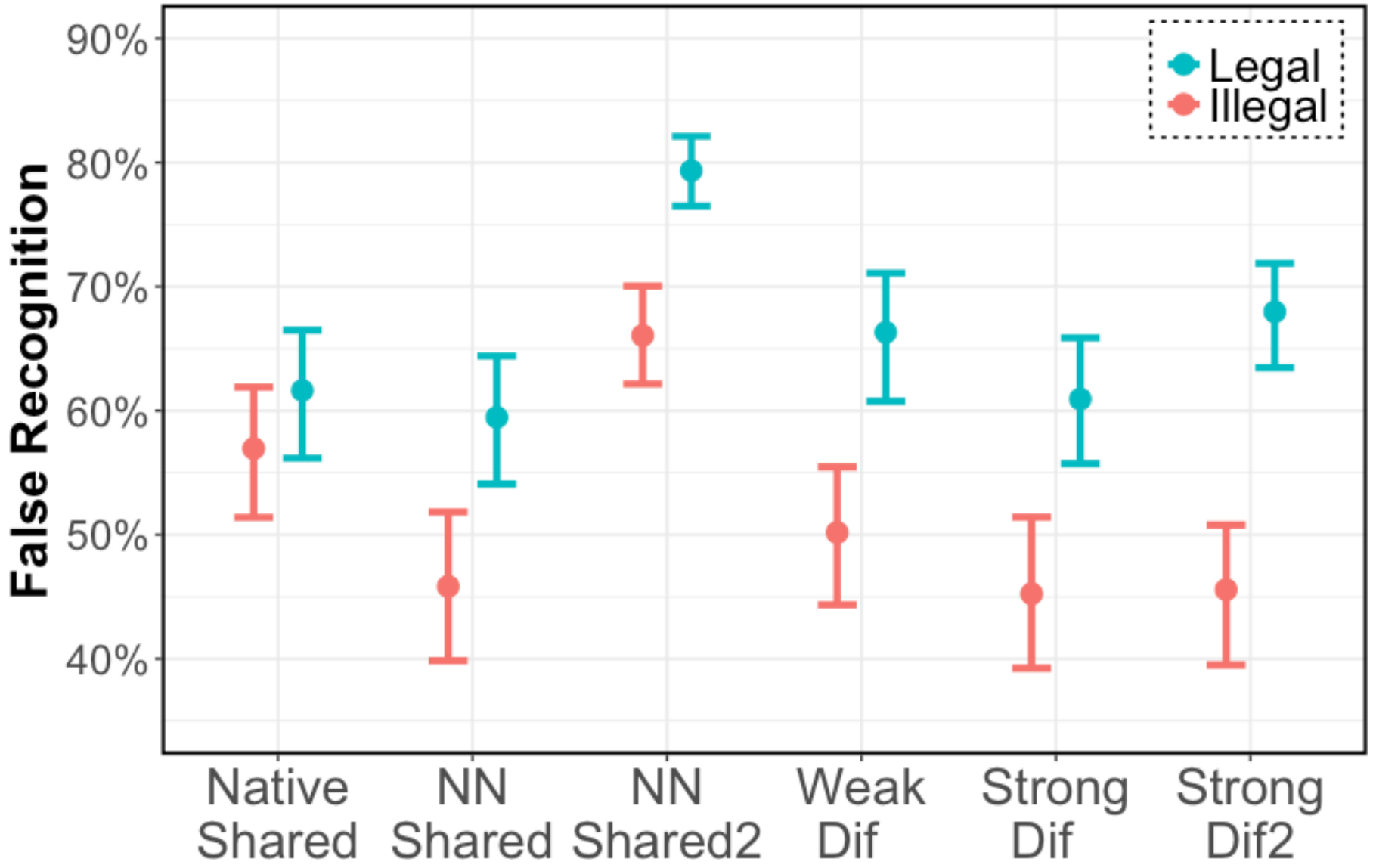
Northwestern University

APPENDIX

Experiment 2 discussion

- What's driving the increase in legality advantage for *Strong-different* condition between Exp1 + 2?
  - Vowel?
    - No: largest increase in legality advantage from Exp1 to 2 for syllables with /i/
  - Talker?
    - No: similar legality advantage for male and female French talkers
    - Adaptation not driven by English talker in different conditions

Experiments 1 + 2 results



Experimental criteria

Condition	Passing Rate
Native Shared	52%
NN Shared	65%
NN Shared2	42%
Weak Different	56%
Strong Different	56%
Strong Different2	45%