

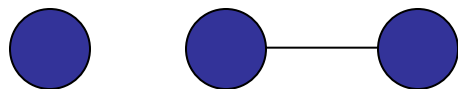
# Finding wholes with configural learning

(Kapatsinski, 2009, *Language*)

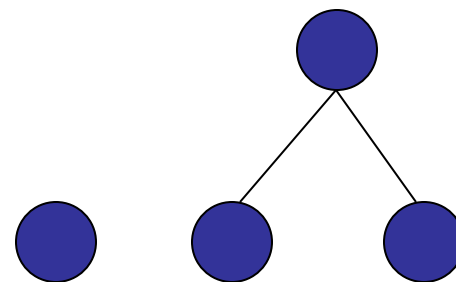
# What is the nature of linguistic constituency?

## Dependency-based vs. hierarchical

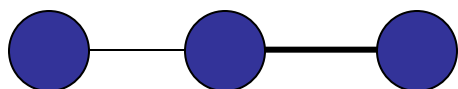
Gradient vs. categorical



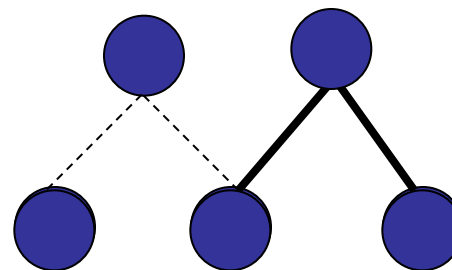
Anderson & Ewen 1987; Hudson 1980



Fudge 1969, Selkirk 1982



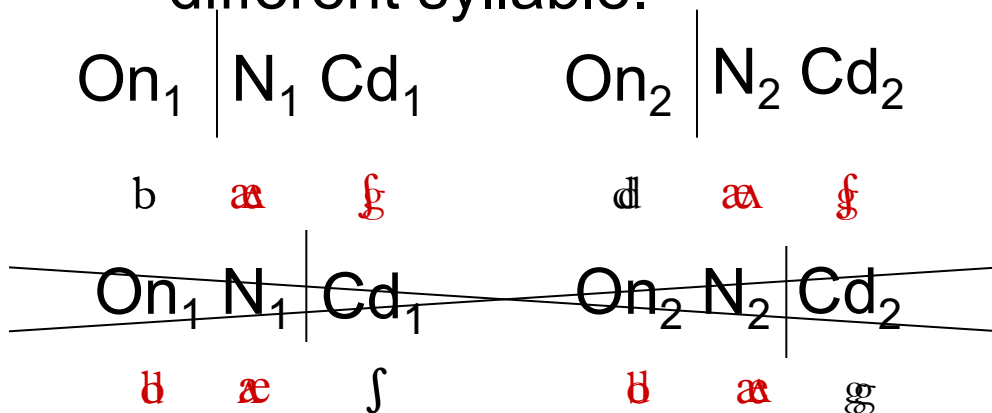
Vennemann 1988



Berg 1995; Warker & Dell 2006

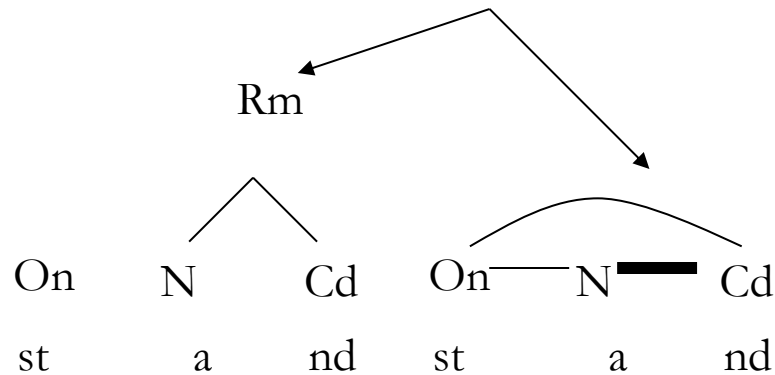
# Syllabic constituency in English

- English syllables tend to have an onset-rime structure, rather than body-coda structure
- Treiman and Danis (1988), Lee & Goldrick (2008):
  - If English speakers are presented with a list of syllables to memorize, they tend to make errors in which the onset of one syllable is combined with the rime of another syllable, rather than the body of one syllable being recombined with the coda from a different syllable.



# Main question

How should we represent syllabic constituency?



On<sub>1</sub> | N<sub>1</sub> Cd<sub>1</sub>

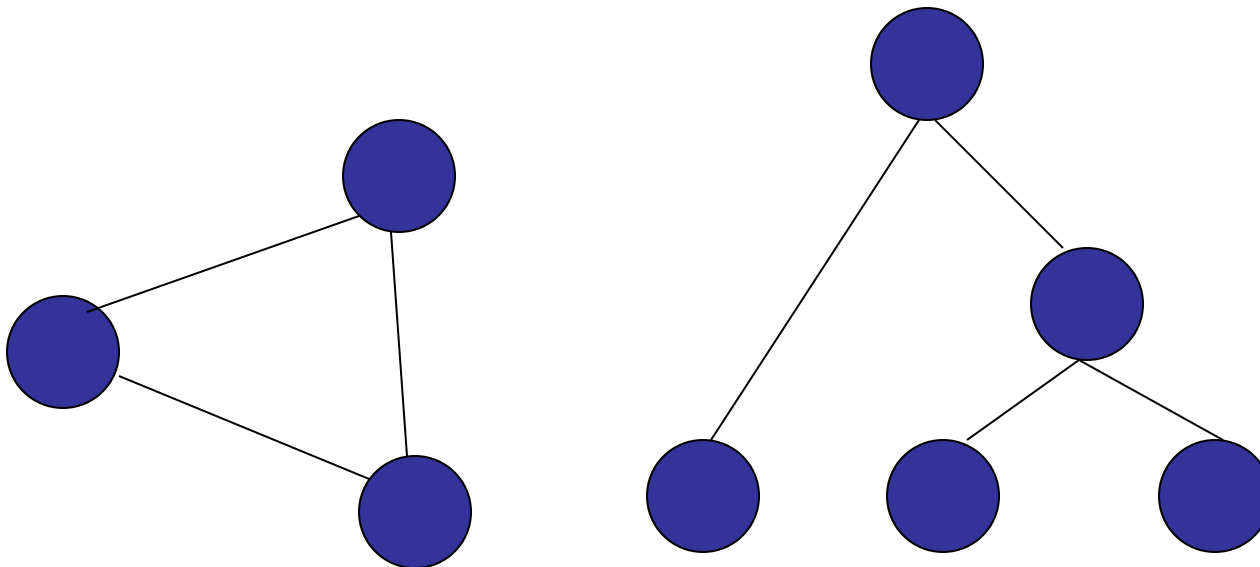
b æ ʃ

On<sub>2</sub> | N<sub>2</sub> Cd<sub>2</sub>

d ʌ g

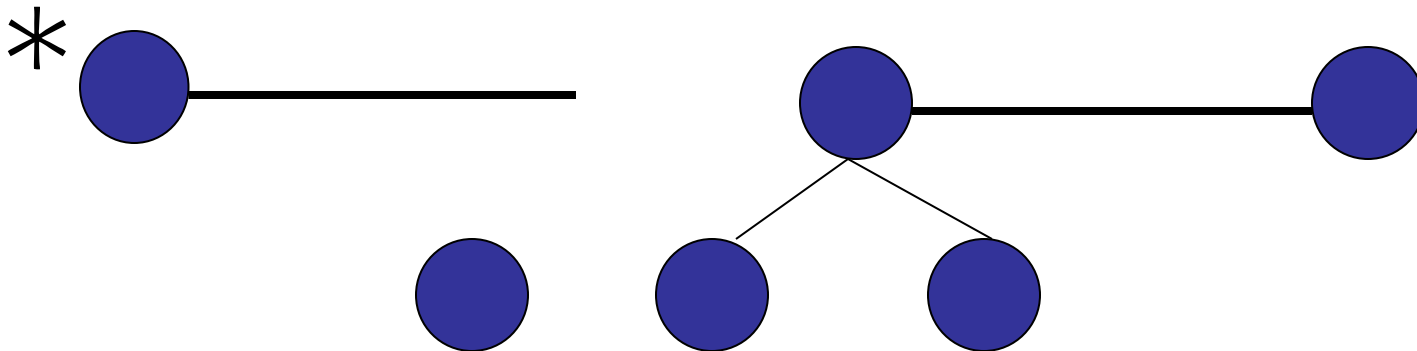
# What does it mean to have a node?

- Under both tree-structural and dependency-based accounts, linguistic structures are represented with a graph
- A graph is a set of nodes connected by links



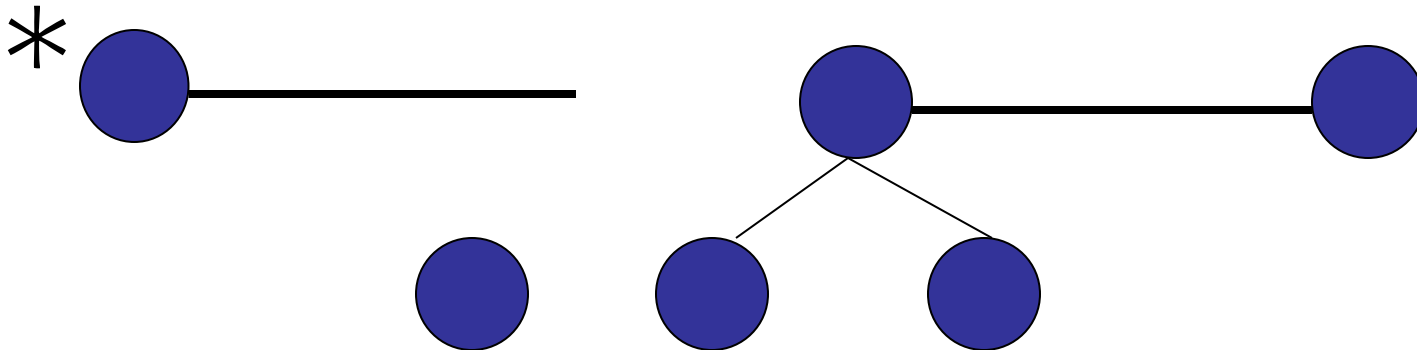
# What does it mean to say that the rime is allocated a node?

- In a graph, links must connect nodes.
- A node is something that can be linked to / associated with something else



# What does it mean to say that the rime is allocated a node while the body is not means to say that the rime can be associated with something else while the body cannot (as easily)

- Thus, to say that the rime is allocated a node while the body is not means to say that the rime can be associated with something else while the body cannot (as easily)
- I.e., the rime is more **associable** than the body



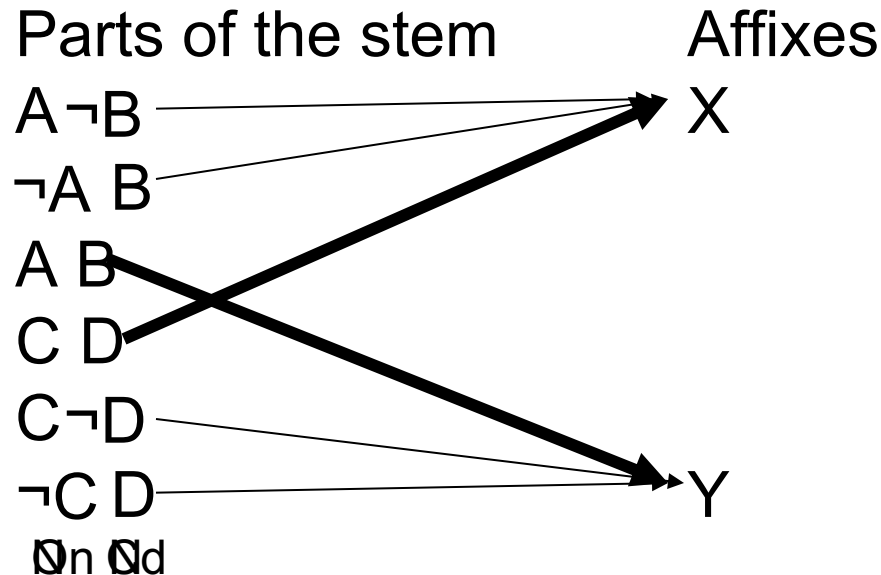
# Configural learning

The whole should not be associated with the same response that's appropriate when one of it's parts is presented without the other.



# XOR learning

- The parts and the whole are associated with different affixes.
- For instance, if  $/æ\zeta/$  is paired with  $/num/$  than  $/æC/$  would be paired with  $/mɪn/$ , as would  $/V\zeta/$ .
- In general,



# XOR learning

## Stage I

- CæC → num
- CΛC → mIn
- CV∫ → num
- CVg → mIn

## Stage II

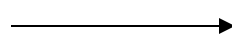
- ❖ Cæ∫ → mIn
- ❖ CΛg → num

Prefix

mIn-Cæ∫

Suffix

Cæ∫-mIn



Subjects exposed to rime-affix pairings

- CæC → num
- CΛC → mIn
- ∫VC → num
- gVC → mIn

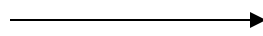
- ❖ ∫æC → mIn
- ❖ gΛC → num

Prefix

mIn-∫æC

Suffix

∫æC-mIn



Subjects exposed to body-affix pairings

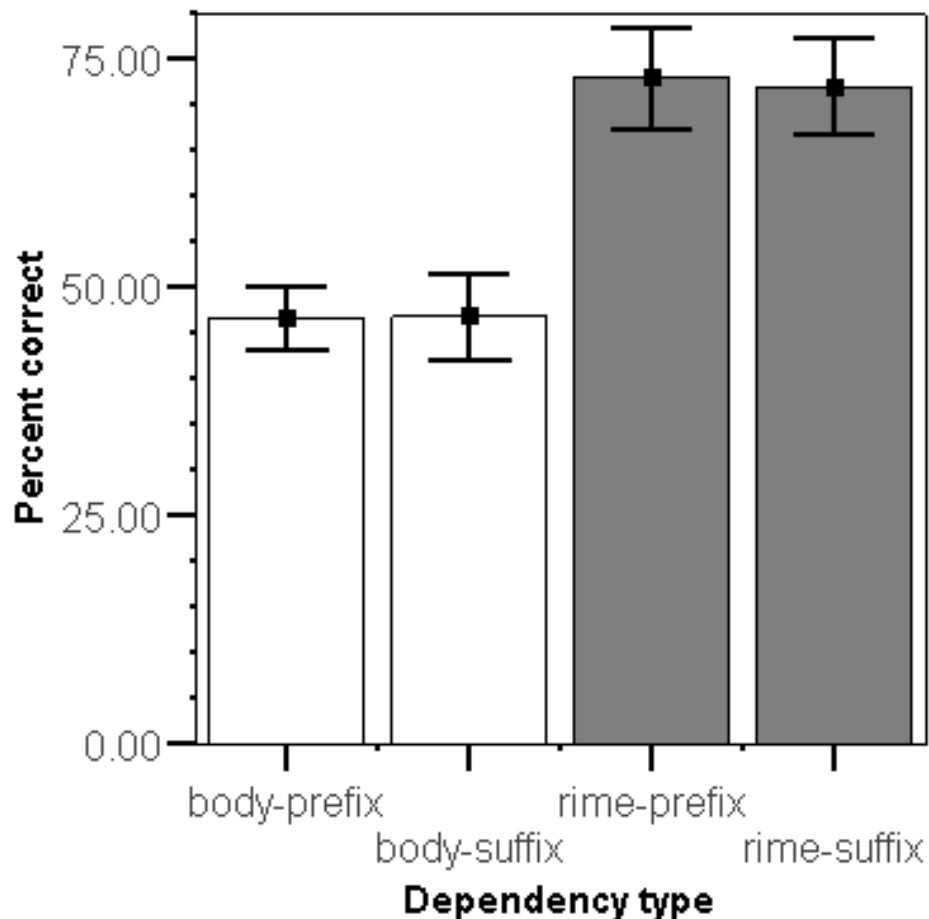
# Task

- During training, listen to stem-affix pairs
- During testing, affix replaced with noise
- Press the button labeled with the right affix

Are constituents (rimes)  
more associable than  
non-constituents (bodies)?

# Rimes are more associable than bodies

$t(33)=5.955, p<.0005$



/mIn/-/ʃæ/

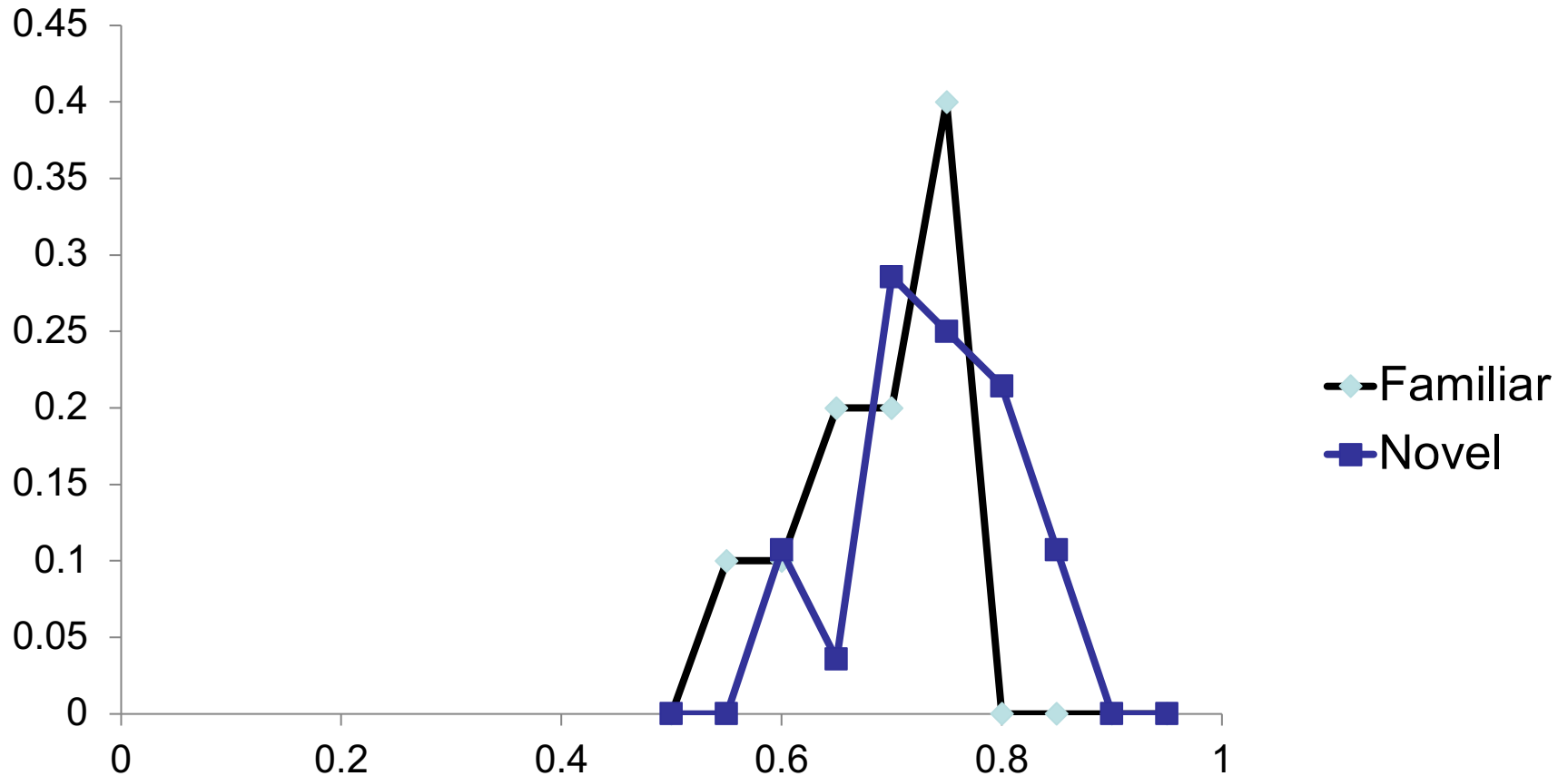
/mIn/-/æʃ/

/ʃæ/-/mIn/

/æʃ/-/mIn/

Are learners learning rime-affix  
associations or  
syllable-affix associations?

# They are learning rime-affix associations: Familiar and new syllables same



Is the difference between rimes  
and bodies  
due to a difference between  
onsets and codas?

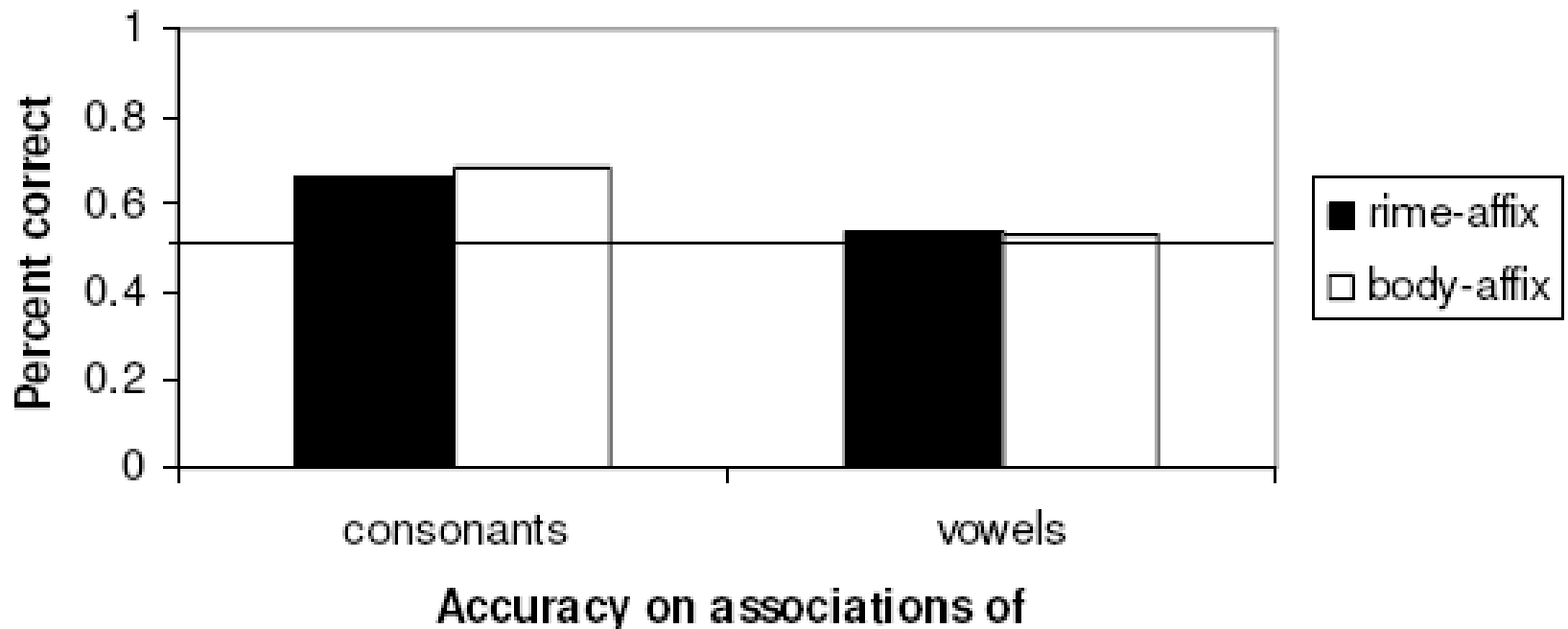


No. Codas are as associable as onsets.

AND

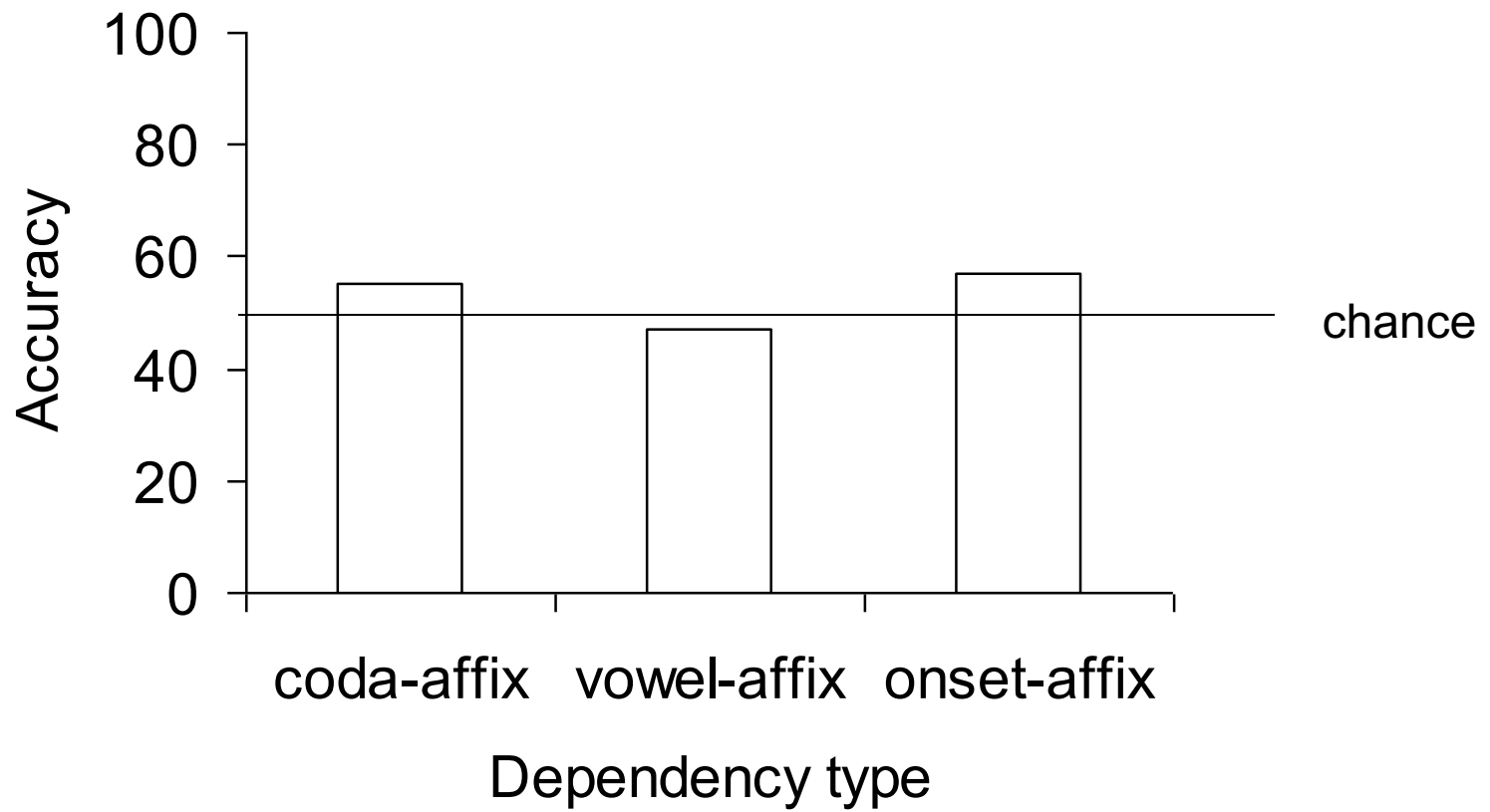
Subjects assigned to rime and body conditions are equally good learners

Vowel and consonant associations prior to training on rimes and bodies



Are learners assigned to the rime condition simply learning wrong segment-affix associations when exposed to rime-affix pairings?

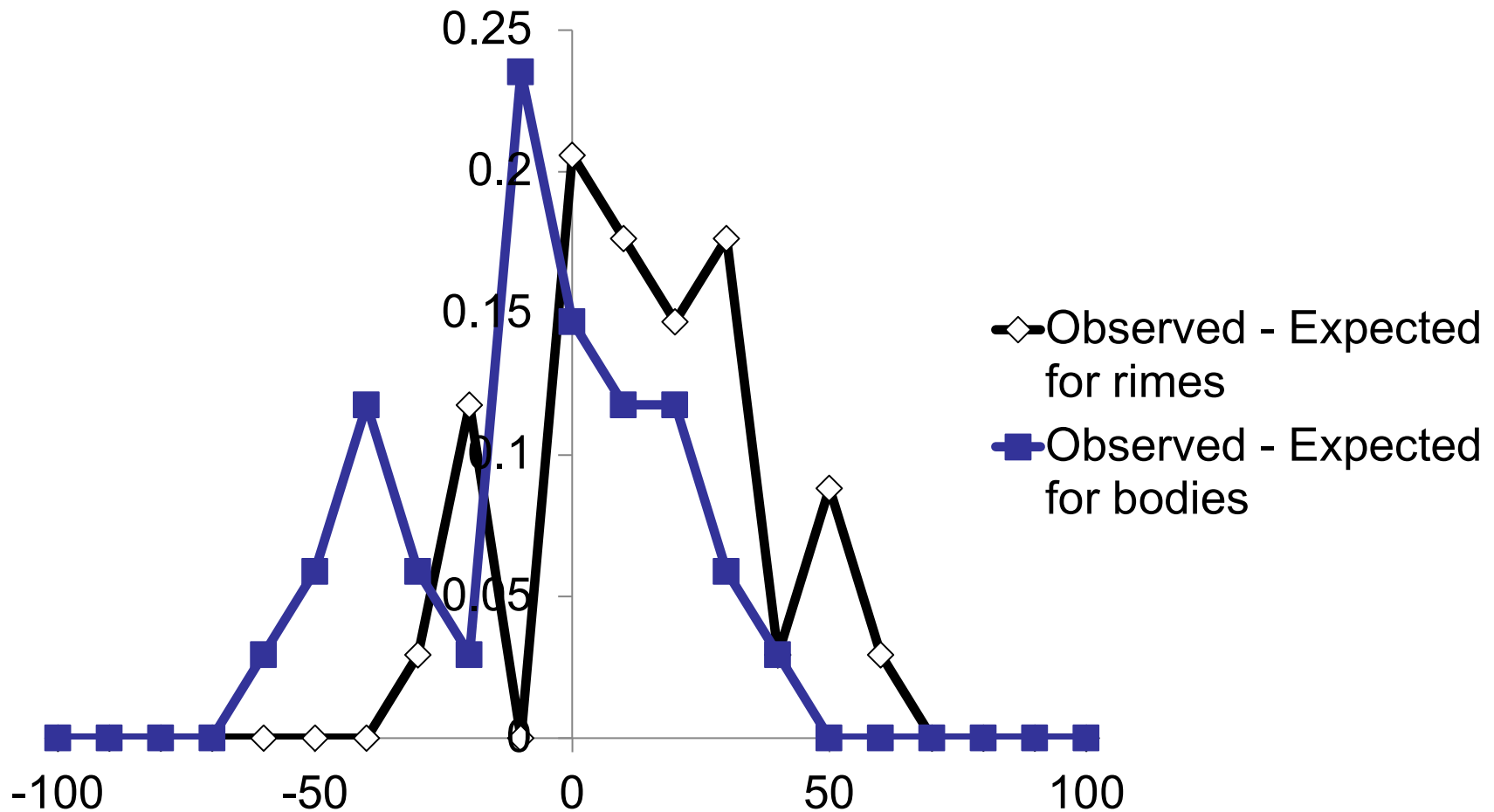
# No. Rime-affix associations are not segment-affix associations



# Are rime-affix associations really segment-affix associations?

- What accuracy could we expect if subjects relied on segment-affix associations?
- Subtract the minimum of each subject's accuracy on consonant-affix dependencies and his/her accuracy on vowel-affix dependencies from 1.
- e.g.,
  - Coda accuracy = .25
  - Vowel accuracy = .73
  - Estimated rime accuracy =  $1 - .25 = .75$

# Observed vs. expected accuracy on rimes vs. bodies



For rimes, observed >> estimated:  $t(33) = 3.78, p=.0006$

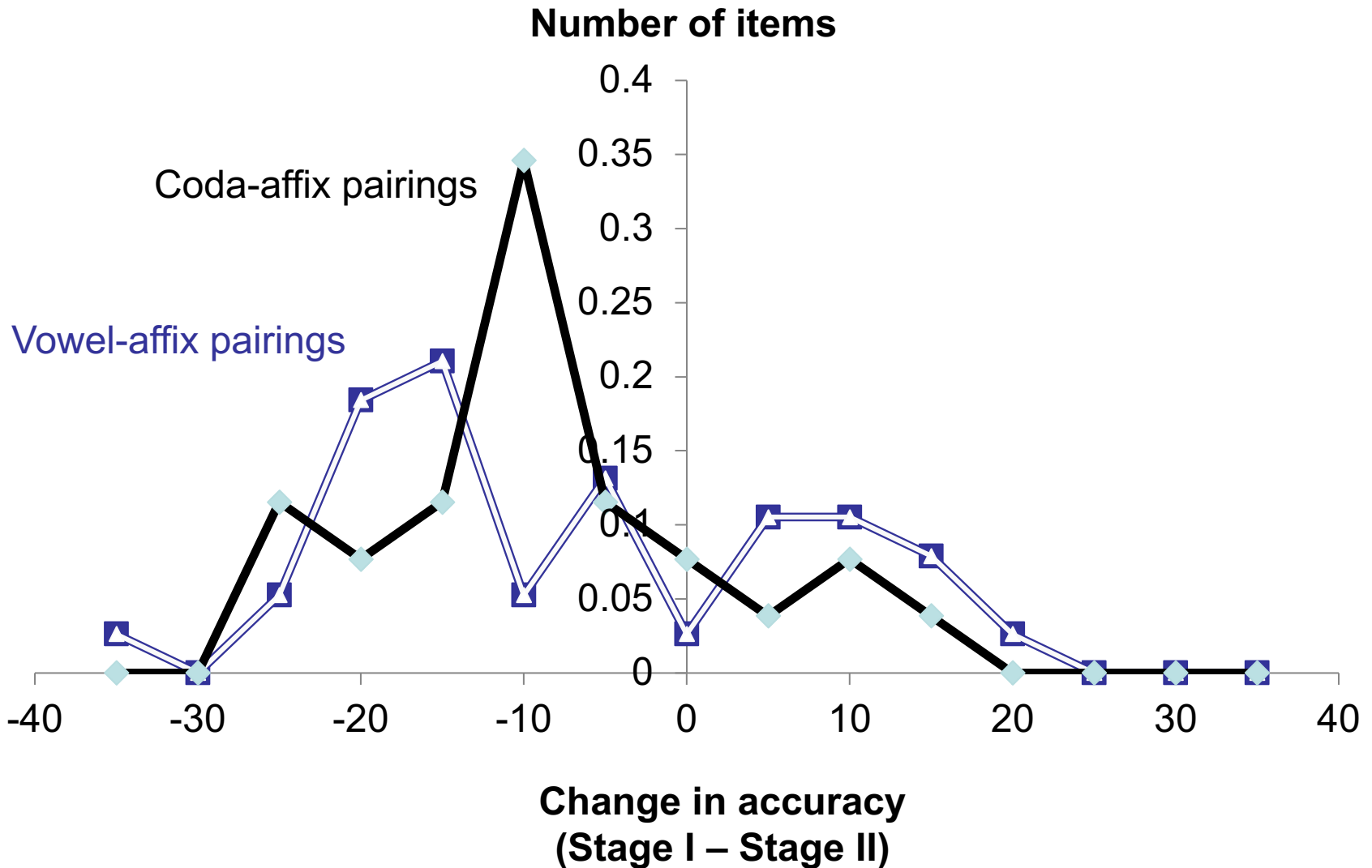
For bodies, no difference  $t(33) = -1.3, n.s.$

Are rimes elements?

# Rimes are not elements

- Accuracy on both consonant-affix and vowel-affix dependencies decreases with both rime-affix and body-affix training (all  $p < .01$ )
  - Hear æʃ-min → learn æ-min, ʃ-min

# Accuracy on segments tends to decrease





# Rimes are not elements

- Accuracy on both consonant-affix and vowel-affix dependencies decreases with both rime-affix and body-affix training (all  $p < .01$ )
  - Hear æʃ-mɪn → learn æ-mɪn, ʃ-mɪn
- Segments contained in a rime or a body that is paired with a certain affix are parsed out of the signal when the rime or the body is presented, thus becoming associated with the affix appropriate for the rime or body

# Conclusion

- Rimes are more associable than the bodies and rimes can have associations that their component segments do not have
- This is predicted by the hierarchical account of constituency but not by the dependency-based account
- This claim needs to be verified separately at different levels in the linguistic hierarchy.
- One way in which this can be done is using XOR learning and related configural learning paradigms (e.g., biconditional discrimination, Saavedra 1975) whose essential feature is that the associations of the whole are not associations of the parts.

# What makes something associable?

- Is it useful for reducing error, i.e., it's a predictive cue? (e.g., Goldstone, 1994)
- Do units used together fuse together (Bybee, 2002) into larger wholes?
- If so, is the mechanism prediction-based or Hebbian?
  - Might be different for local and long-distance dependencies
- Specifically for rimes vs. bodies:
  - Overall statistics of the language (Kessler & Treiman 1997, Lee & Goldrick 2008)
  - Between-part co-occurrence within a specific rime (Lee & Goldrick 2008)
  - Potential lexicality (e.g., Cutler et al. 2001)