Silent articulation affects error patterns in inner speech

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Speech errors reflect levels of representation…

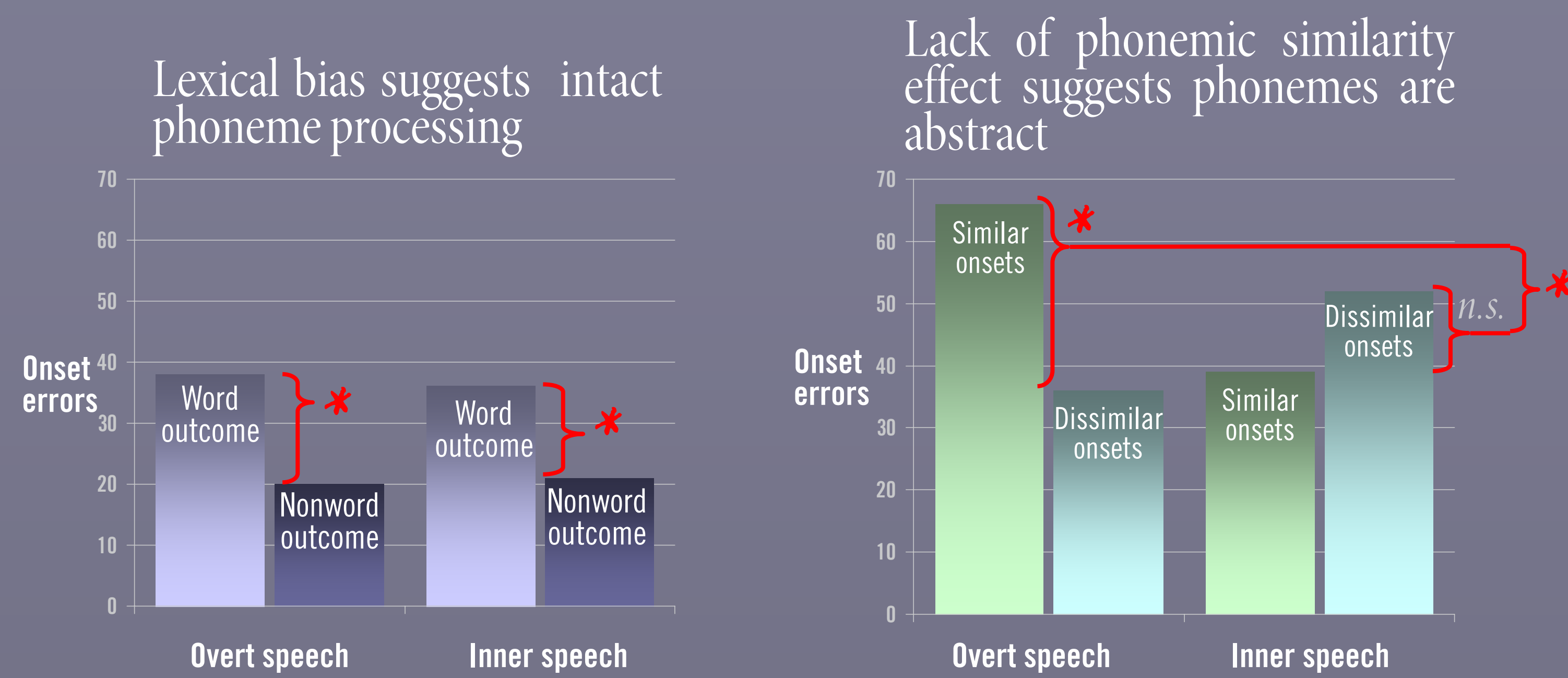|		
reef → kelp	Word error (semantically related)	
reef → beef	Phoneme error (with lexical bias)	
reef → leaf > reef → beef	Phoneme error (with phonemic similarity effect)	
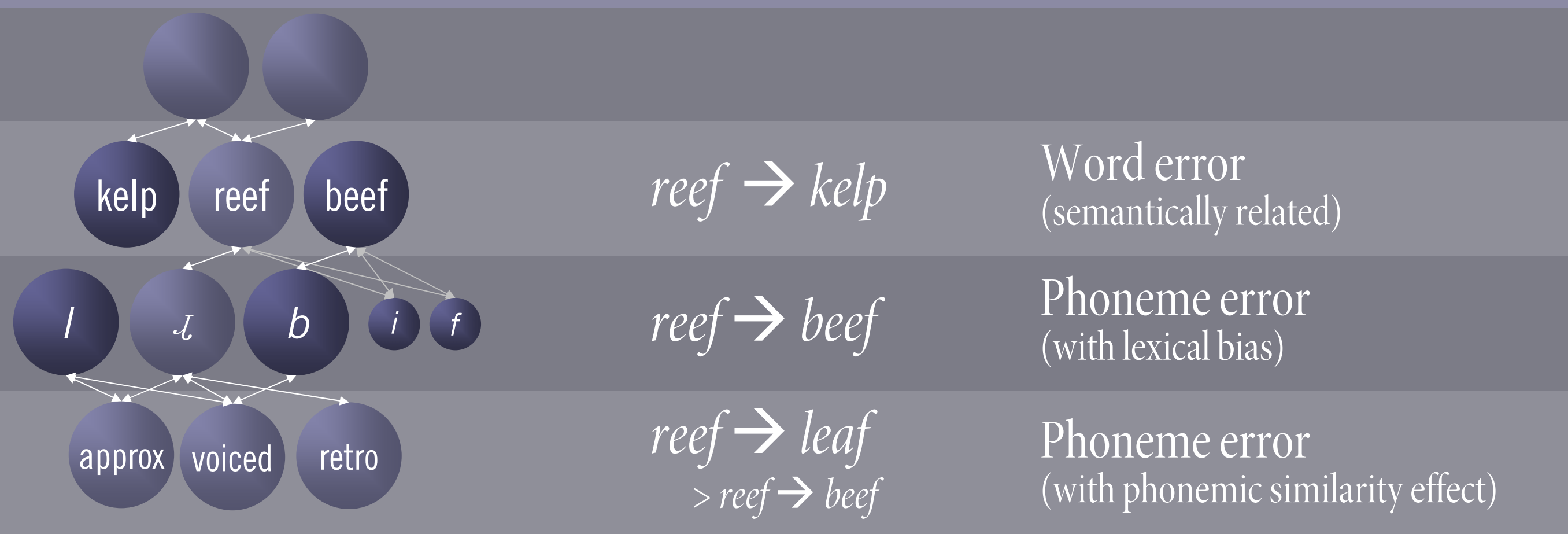
… and inner speech could, in principle, operate on any of these levels

Three perspectives:

1. Abstract linguistic representations. Awareness of inner speech, and therefore inner speech errors, occurs at the phonological level (e.g. Oppenheim & Dell, 2008; Wheeldon & Levelt, 1995)

2. Embodied sensory-motor imagery. Inner speech is like overt speech, minus the sound or motor movement (e.g. Dell, 1978; Postma & Noordanus, 1996).

3. Flexible abstraction. Inner speech varies in the extent to which sensory-motor representations are used

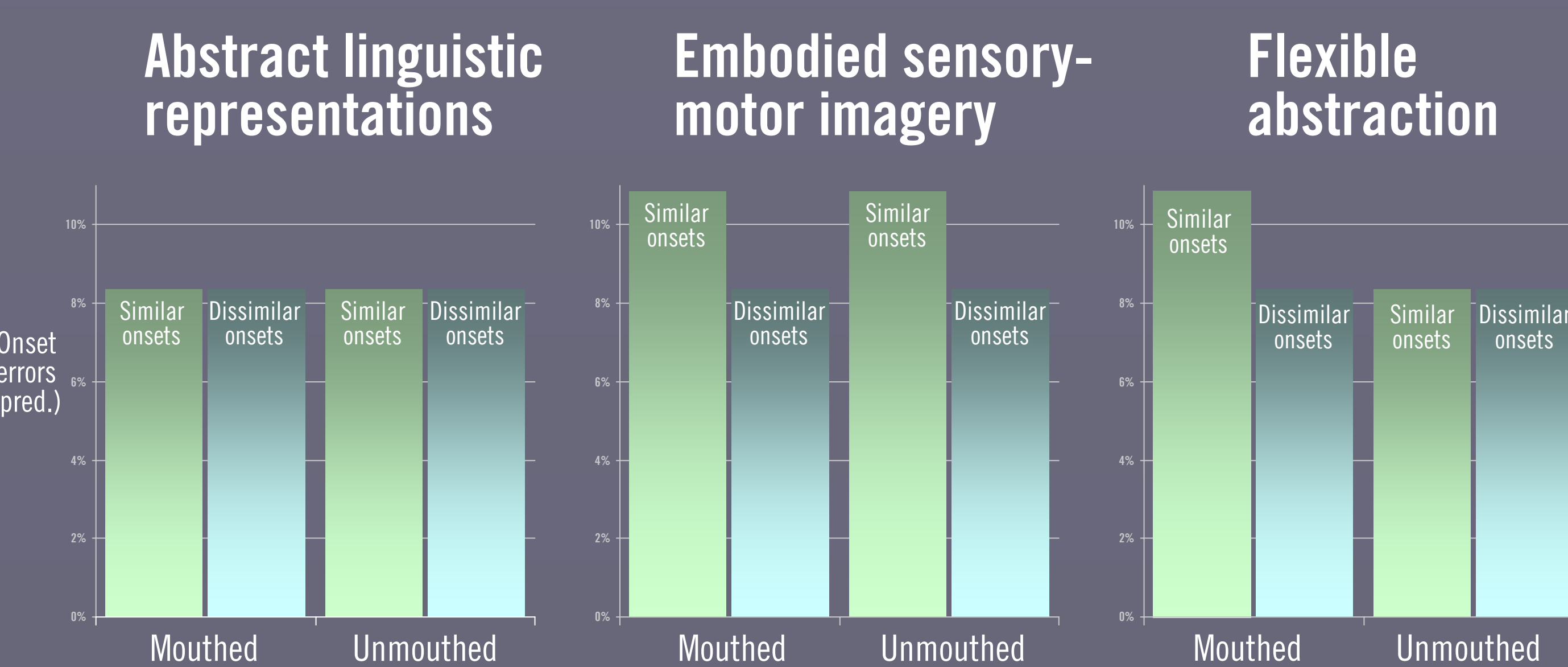### Compared to overt speech (from Oppenheim & Dell, 2008)

Lexical bias suggests intact phoneme processing

Lack of phonemic similarity effect suggests phonemes are abstract

Where is the crucial difference between inner and overt speech?

	Motor	Sound
Overt speech	X	X
Inner speech	–	–
New experiment → Mouthed speech	X	–

Three predictions:

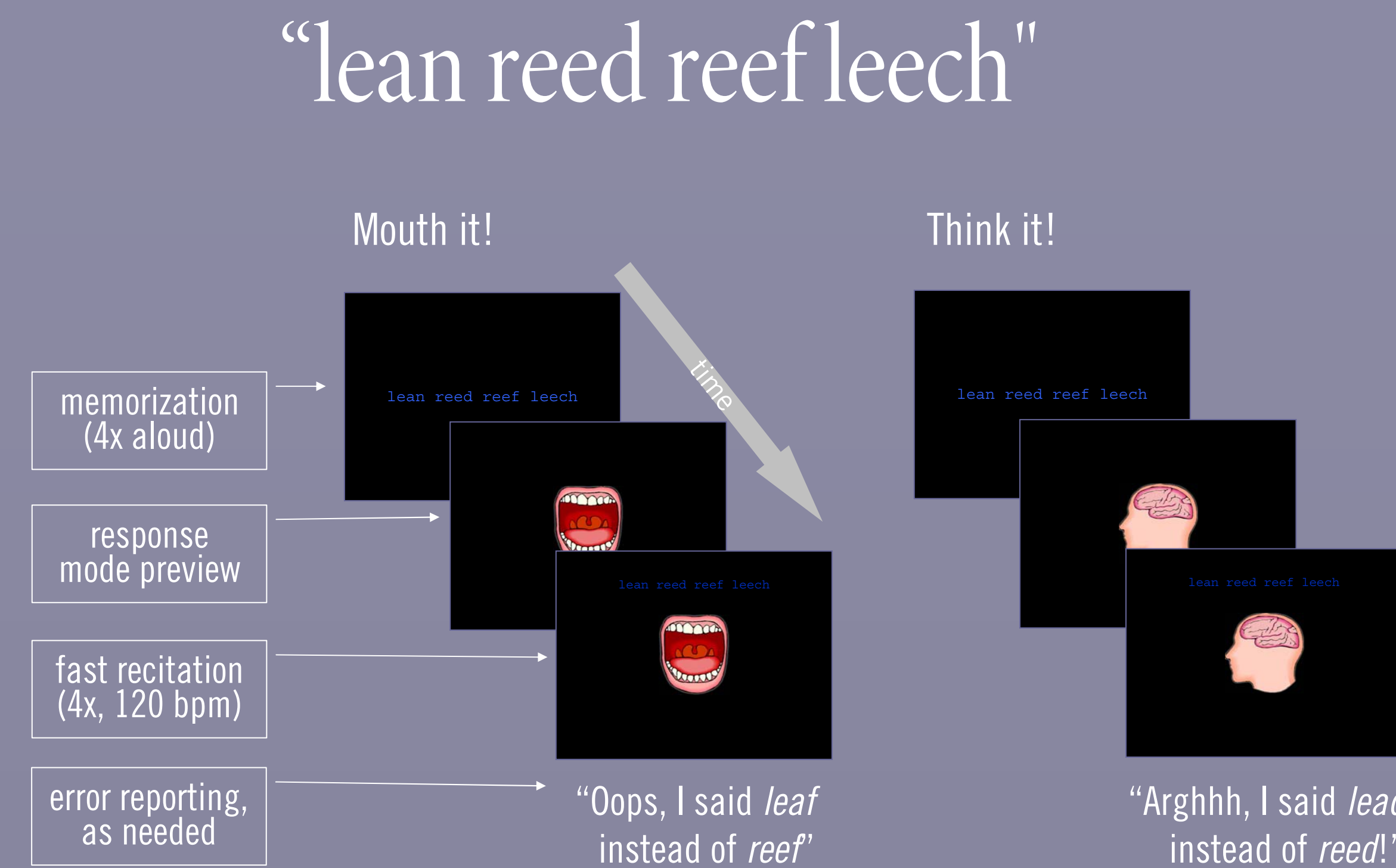| Abstract linguistic representations	Embodied sensory-motor imagery	Flexible abstraction
Inner speech will still be created and monitored as abstract phonemes	Already embodied imagery will not get more embodied	Mouthing will require more detailed inner speech

Methods

"lean reed reef leech"

Mouth it!

| memorization (4x aloud) |
| response mode preview |
| fast recitation (4x, 120 bpm) |
| error reporting, as needed |

"Oops, I said *leaf* instead of *reef*"

Think it!

"Arghhh, I said *lead* instead of *reed*!"

32 matched sets of stimuli

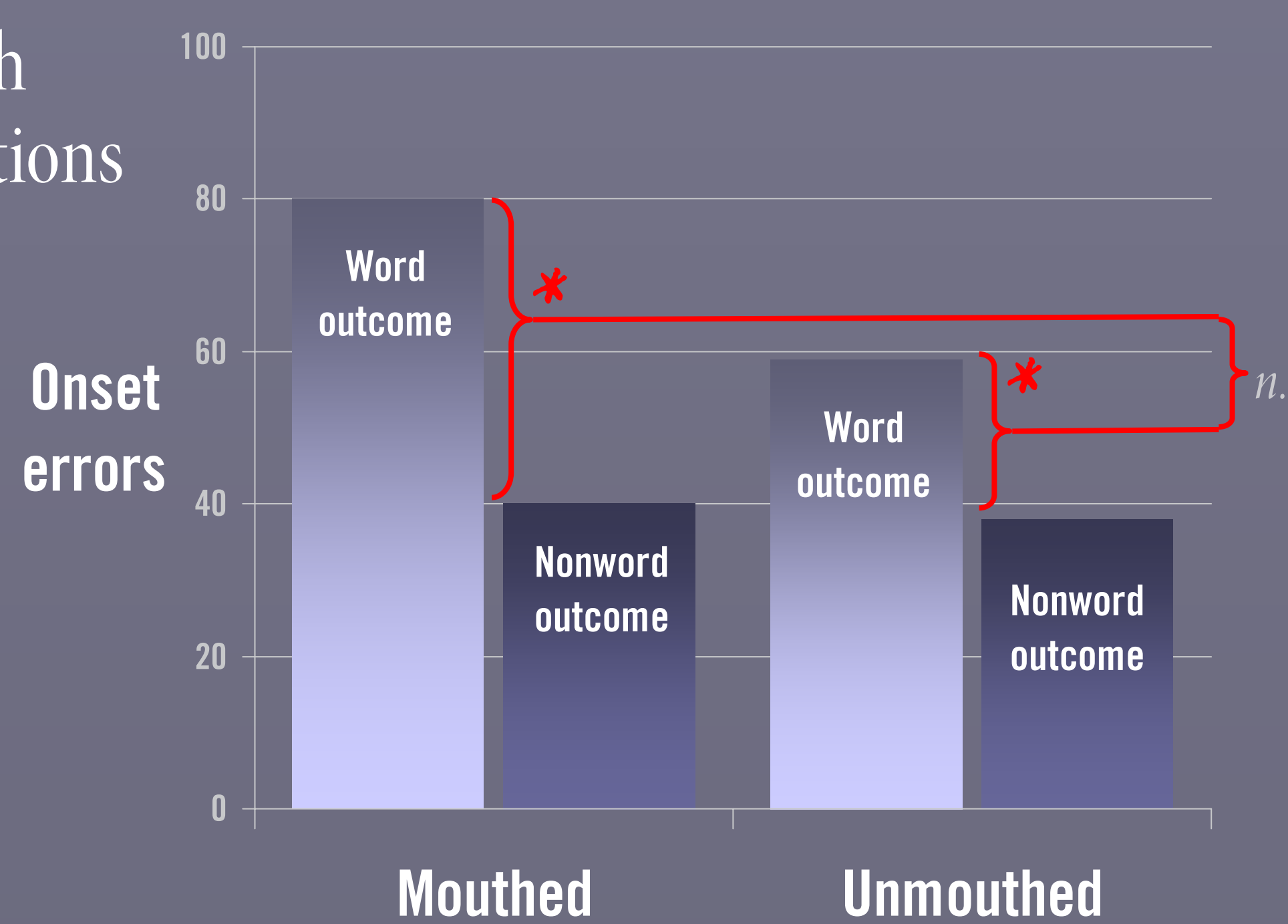|	Similar onsets				Dissimilar onsets			
Word outcome	lean	reed	reef	leech	**b**ean	reed	reef	**b**eech
Nonword outcome	lean	reed	wrea**th**	leech	**b**ean	reed	wrea**th**	**b**eech

80 participants

Results

Similar overall error distributions

2462 total self-reported errors
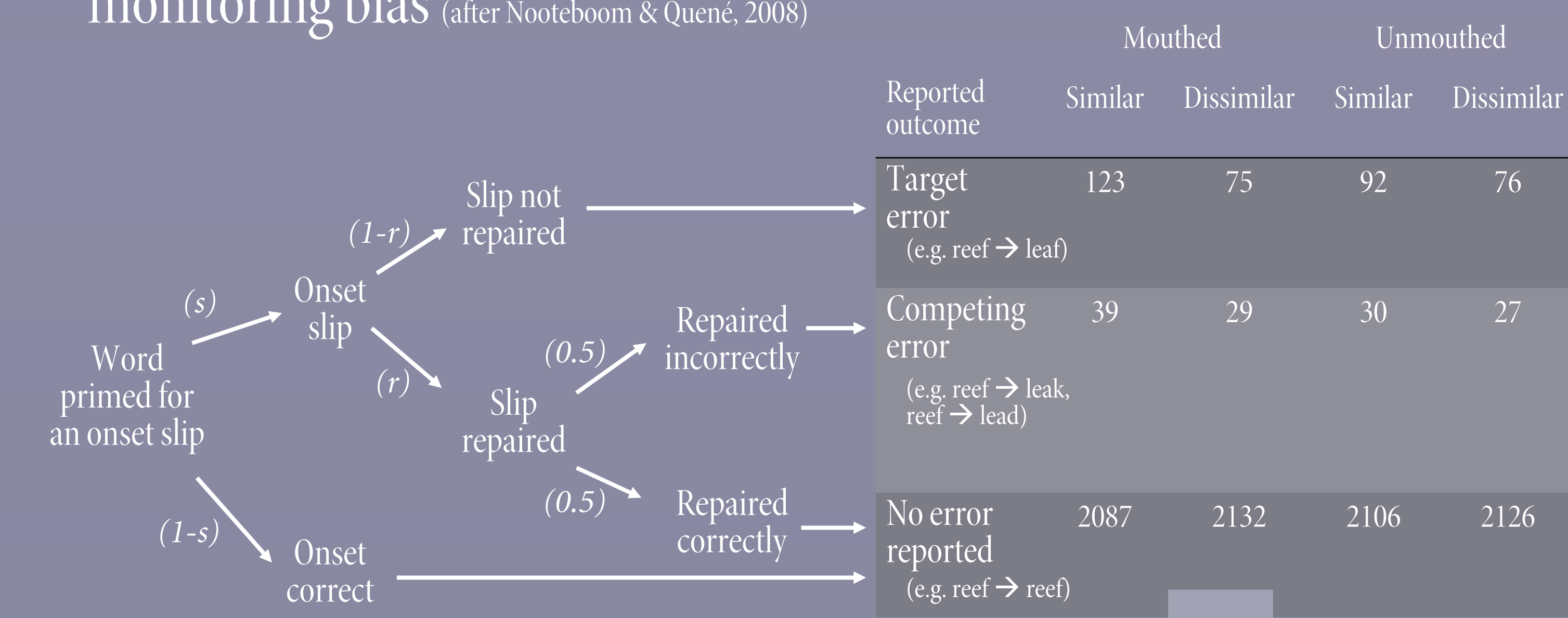- 1265 mouthed
- 1197 unmouthed
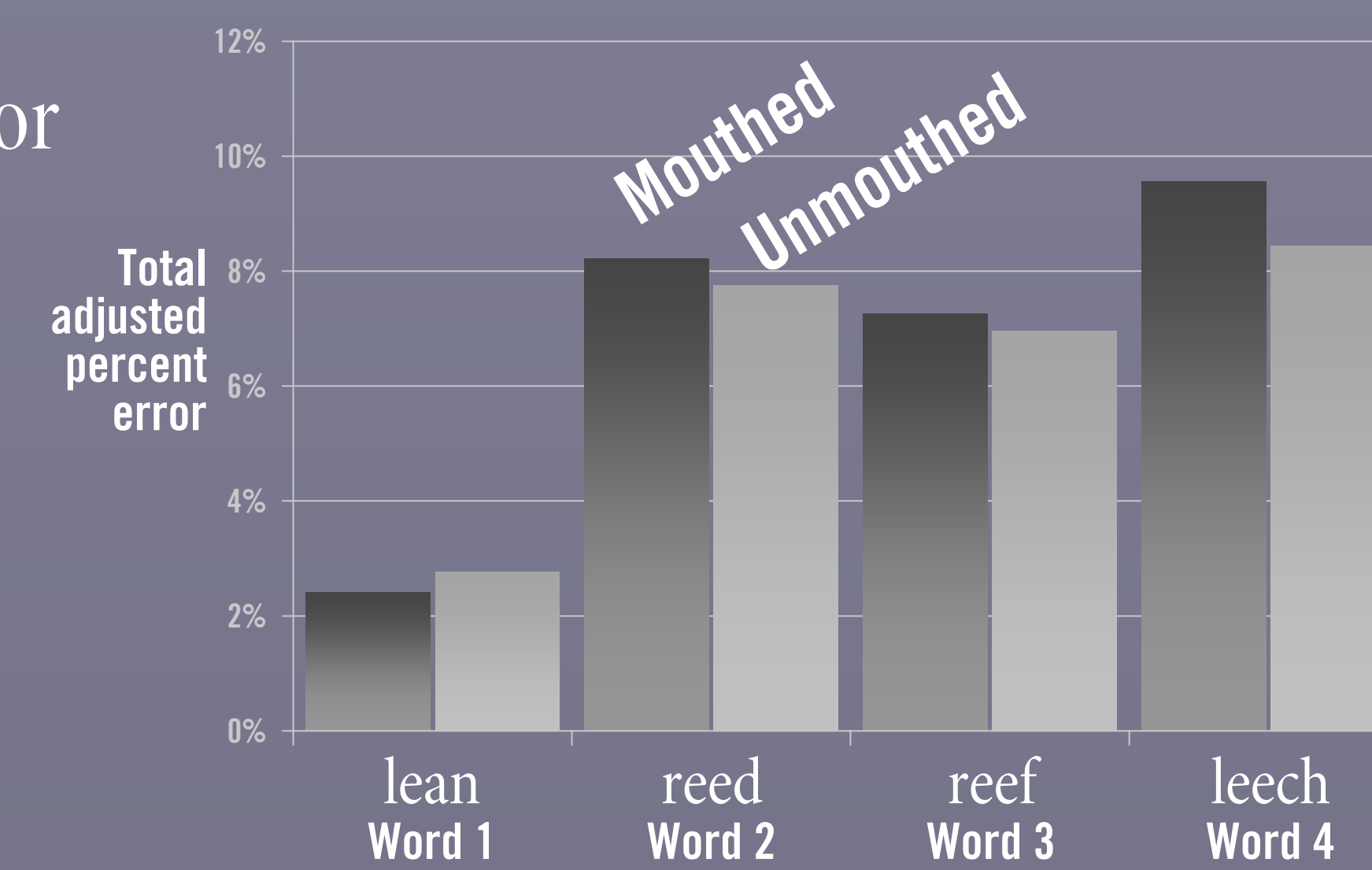
Lexical bias in both mouthing conditions
(no significant interactions)

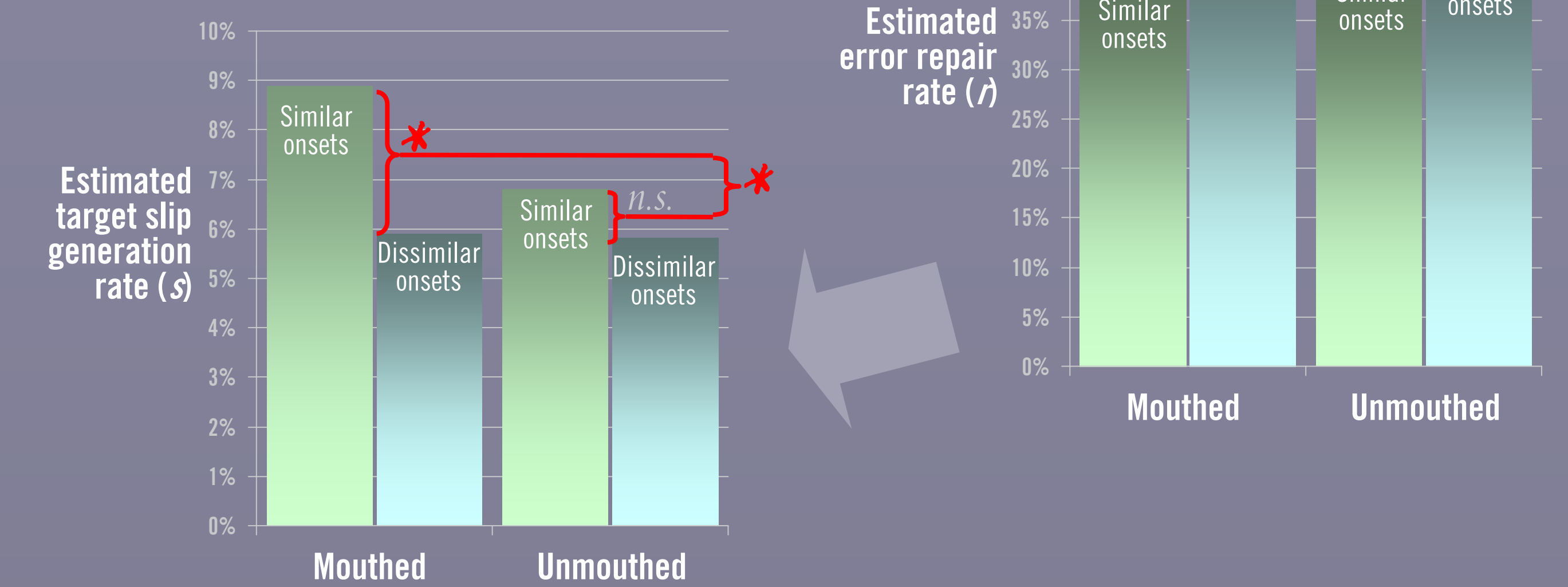### Stronger phonemic similarity effect in mouthed inner speech

Correcting for potential monitoring bias (after Nooteboom & Quené, 2008)

Reported outcome	Mouthed Similar	Mouthed Dissimilar	Unmouthed Similar	Unmouthed Dissimilar
Target error (e.g. reef → leaf)	123	75	92	76
Competing error (e.g. reef → leak, reef → lead)	39	29	30	27
No error reported (e.g. reef → reef)	2087	2132	2106	2126

Minimal error-repair biases because competing errors show a distribution similar to target errors
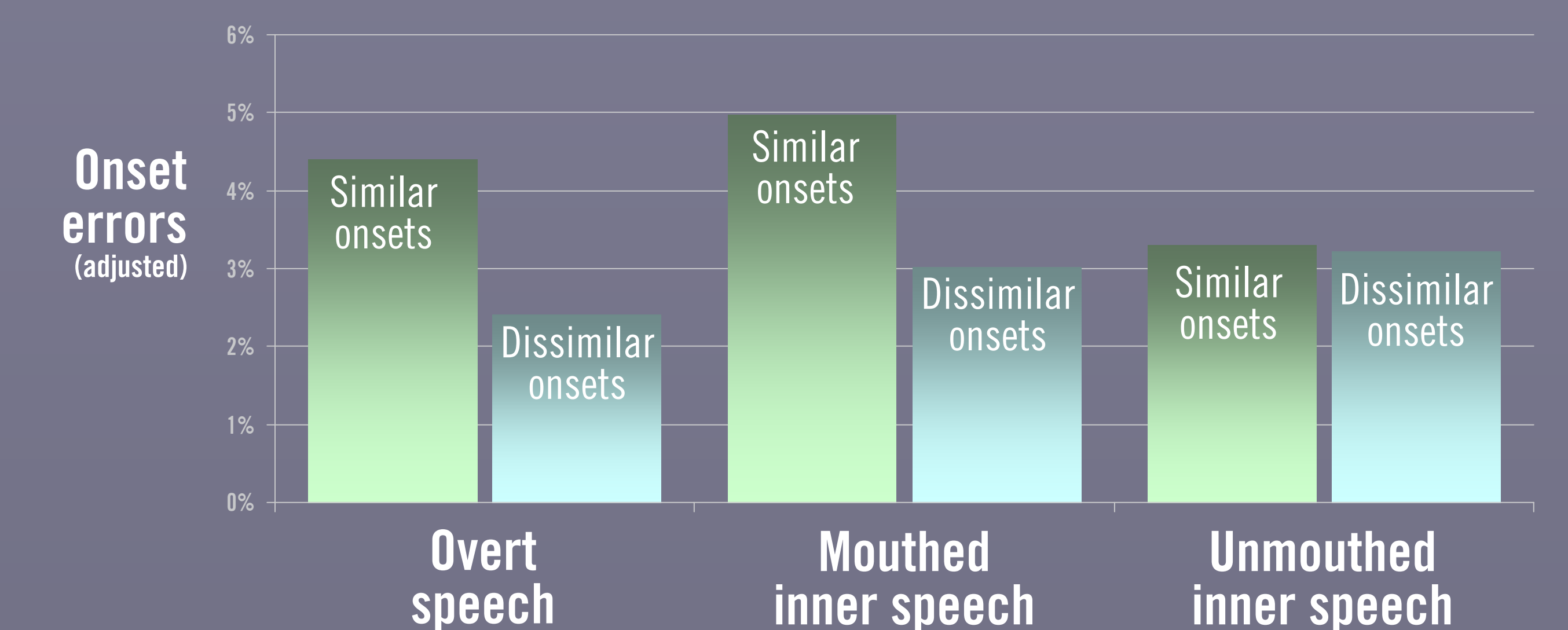
The mouthing x similarity interaction remains

Discussion

The big picture
Combined data from the current study and Oppenheim & Dell (2008)

- Silent articulation, without auditory monitoring, is sufficient to create a phonemic similarity effect in speech errors

- Inner speech tends to be specified to at least the phoneme level, but not necessarily to the level of articulatory representations
  - This finding replicates Oppenheim & Dell (2008)
  - Argues against a strong embodiment account of inner speech, where cognition is necessarily based in sensory-motor processes

- Additional motor planning, or execution, can create a form of inner speech that incorporates articulatory information
  - Argues against a strong abstraction account of inner speech

- Speakers can flexibly adjust the abstractness of their imagery
  - This claim explains variable results in the field (e.g. Brocklehurst & Corley, 2009; Dell, 1978)

References

Brocklehurst, P. & Corley, M. (2009). Lexical bias and the phonemic similarity effect in inner speech. Paper presented at the 15th Annual Conference on Architectures and Mechanisms for Language Processing, 7-9 September 2009, Barcelona.

Dell, G. S. (1978). Slips of the mind. In M. Paradis (Ed.), *The fourth LACUS forum* (pp. 69-75). Columbia, S.C.: Hornbeam Press.

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Nooteboom, S., & Quené, H. (2008). Self-monitoring and feedback: A new attempt to find the main cause of lexical bias in phonological speech errors. *Journal of Memory and Language, 58*(3), 837-861.

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