Bridging comprehension and production: A computational model of error correction

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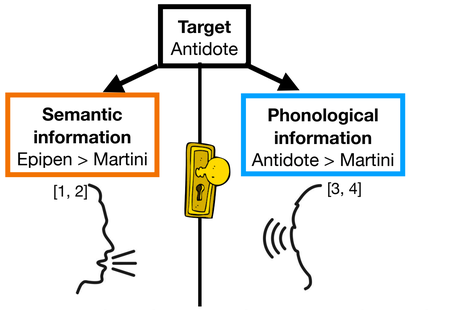
Introduction

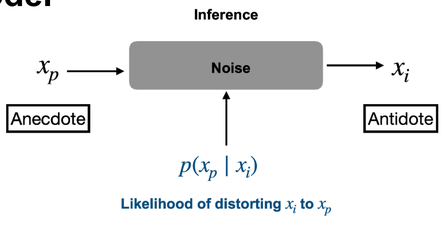
How do comprehenders and speakers **monitor errors**?
How are semantic and phonological **cues** weighted?
How do comprehension and production **interact**?

She saved him from the poison by administering an…



Integrate production and comprehension

Model



Error correction as Bayesian rational inference

$$p(x_i \mid x_p) \propto p(x_i) \cdot p(x_p \mid x_i)$$

Noise monitor: likelihood of distortion

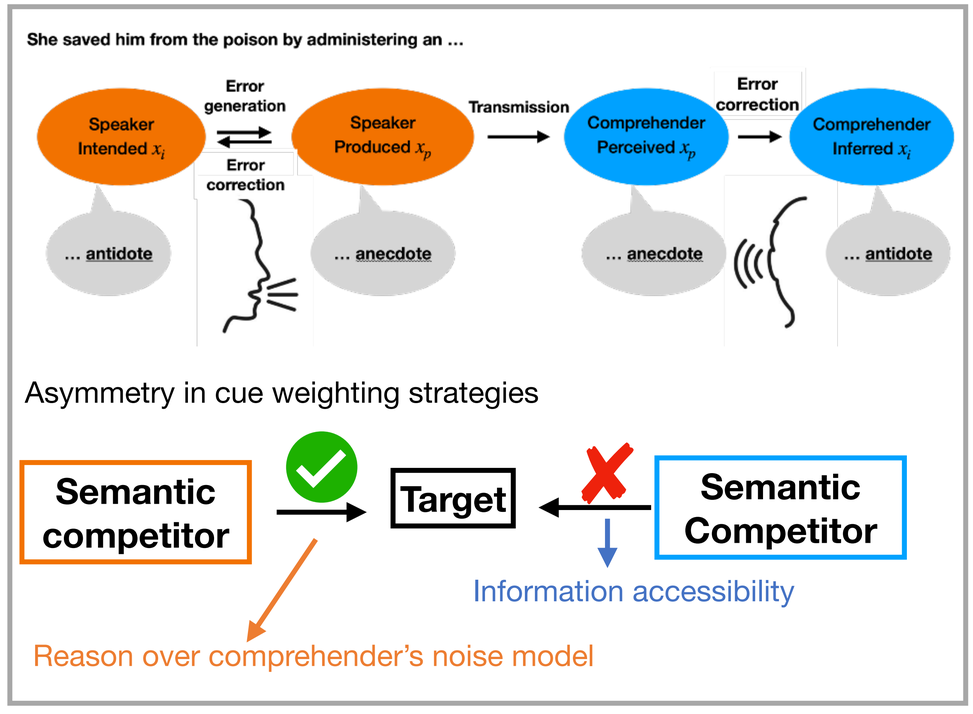
$$p(x_i \mid x_p) \approx p(x_i) \cdot \underbrace{e^{-[\alpha Phon(x_i,x_p)+\beta Sem(x_i,x_p)]}}_{\text{noise monitor}}$$

Phonological distance — Semantic distance

α : weight/contribution of phonological distance

β : weight/contribution of semantic distance

Overview



Data

Production data:

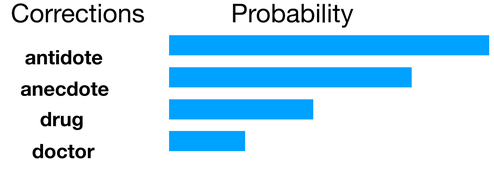
- Fromkin Speech Error Database [5]
- Utterances (N=1024) annotated as ***corrected*** or ***not corrected***

utterance	corrected?
humor is a good ANECDOTE	***False***
it is the question of the HOUR – of the fortnight	***True***

Comprehension stimuli:

- Ryskin et al. 2021 [6] with errors at the end of utterances (N=480)
- Distribution over corrections (N=22,041) from offline reading/editing experiments

She saved him from the poison by administering an **anecdote**



Implementation

Find α and β that minimize **cross entropy loss…**

Production: in predicting whether error was ***corrected*** or ***not corrected***

Comprehension: between model predicted and empirical **probability distribution** over corrections

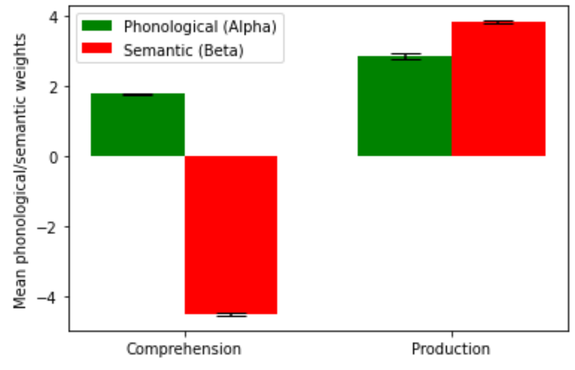
Measures

$P(x_i)$: masking the target using XLNet [7]

$Phon(x_i, x_p)$: phonemic feature-based distance between intended and produced/perceived [8]

$Sem(x_i, x_p)$: pre-trained GloVe embeddings [9]

Key Findings



Comprehenders:

- semantic cues > phonological cues
- More likely to correct semantically dissimilar errors

Speakers:

- More likely to correct semantic competitors

Conclusion

- Asymmetry in error correction between production and comprehension
- Strategic use of cues reflects interaction and iterative reasoning between comprehension and production

References [1] Levelt, W. J. M. (1989). Speaking: From intention to articulation. [2] Hartsuiker & Barkhuysen (2006). Language and Cognitive Processes. [3] Gibson et al. (2013). Psychological science. [4] Ryskin et al. (2018). Cognition. [5] Fromkin (2000). Online database. [6] Ryskin et al. (2021). Neuropsychologia. [7] Yang et al. (2019). NeurIPS. [8] Mortensen et al. (2016). COLING. [9] Pennington et al. (2014). EMNLP.