A pragmatic speaker model can account for the high-frequency bias in referring expression production

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Background

During lexical selection, producers must weigh a label's **accuracy[1]** against its retrieval/production **cost[2].**

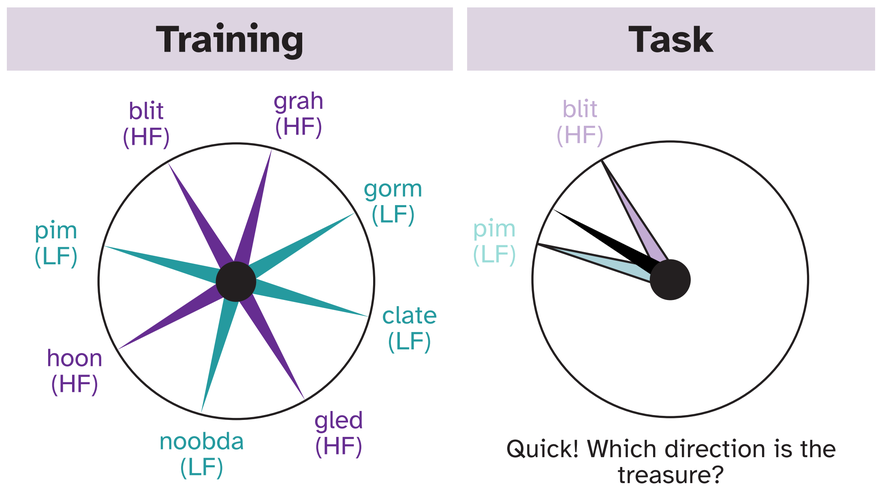
couch: lower accuracy, lower cost

futon: higher accuracy, higher cost

Experimental Data

Koranda, Zettersten, and MacDonald (2020)

Participants were trained on novel compass directions where half of the labels were high-frequency and half of the labels were low-frequency.



Under time pressure, speakers produced "sub-optimal" labels that were less accurate but higher in frequency.

Prior work has demonstrated that rational speech act (RSA) models can capture "sub-optimal" behavior[3].

Information-theoretic (RSA) Model

Pragmatic Speaker (S_1)

$$P_{S_1}(label|angle) \propto L_0(angle|label) - C(label)$$

probability of producing a label for an angle

probability of the listener choosing the correct angle

the cost of retrieving a given label

Literal Listener (L_0)

$$P_{L_0}(angle|label) \propto [\![label]\!](angle)$$

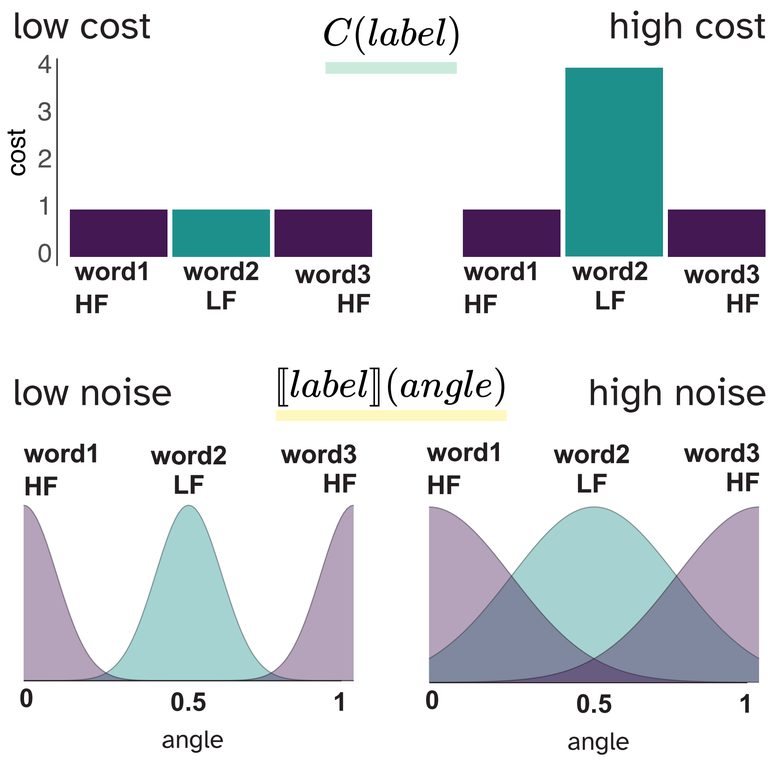
probability of selecting an angle given a label

literal meaning of the label

RSA models assign ***utility*** to referring expressions by incorporating ***retrieval cost*** and ***informativity*** simultaneously into the producer's ***word choice[4]***.

We operationalize retrieval cost as the accessibility of a lexical item and informativity as the probability that a literal listener will navigate toward the named compass direction[4].

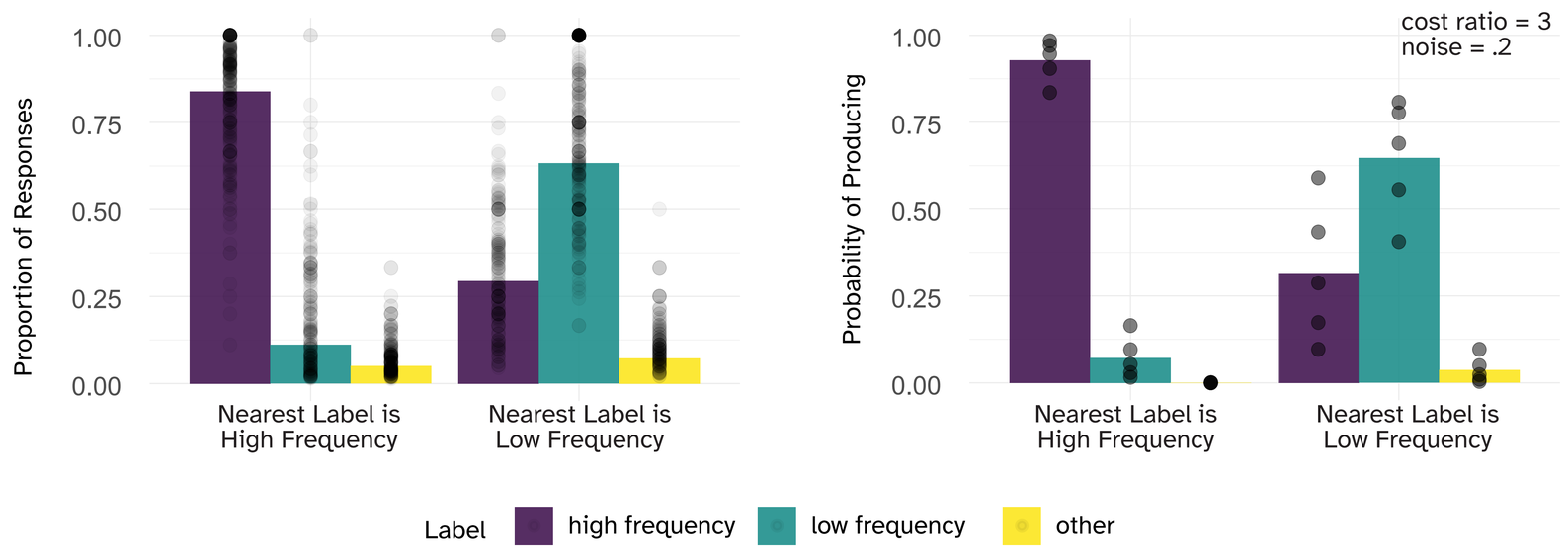
Model Parameters



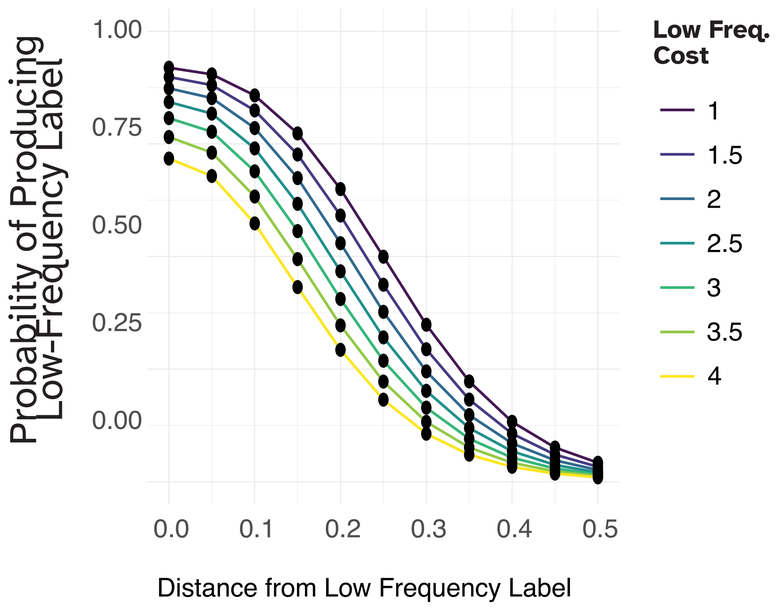
Results

Human participants use less accurate but more frequent labels instead of the more accurate, but less frequent, alternatives.

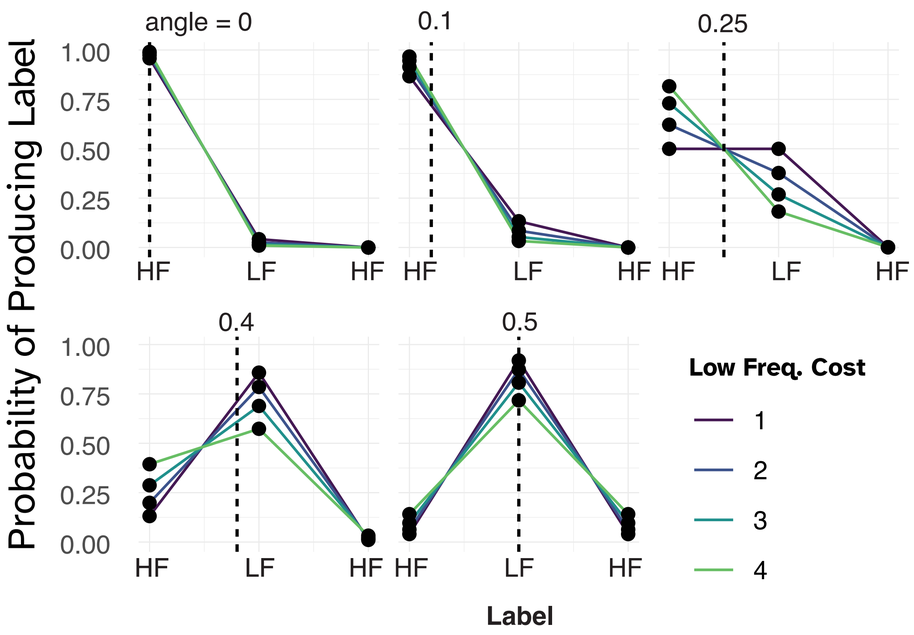
Our model captures this high-frequency bias by incorporating retrieval cost and informativity!



The higher the cost of the low-frequency label, the lower the probability of being produced



The low-frequency word becomes more likely as a function of the distance from the target angle

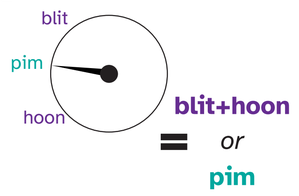


Conclusions

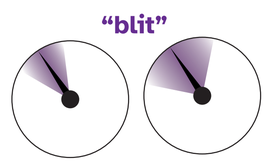
Our model provides clear evidence of optimality in the form of a tradeoff between comprehenders' needs and speakers' resources.

Future Work

Features of production under constraint, such as compounding.



Listeners' ability to recover meaning from an inaccurate speaker.



Acknowledgements

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References

1. Levelt, W., Roelofs, A., & Meyer, A. (1999)
2. Dell, G. S. (1986)
3. Degen, J., Hawkins, R. D., Graf, C., Kreiss, E., & Goodman, N. D. (2020).
4. Goodman, N. D., & Frank, M. C. (2016).

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