

Sensorimotor and Linguistic Distributional Knowledge in Semantic Category Production: An Empirical Study and Model

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Hypotheses

- Accessing semantic concepts during a category production task would rely on both sensorimotor similarity and linguistic distributional information, with linguistic information providing a computationally cheaper shortcut¹.
- Activation in the conceptual system would spread *indirectly* (i.e. via indirect associations).

Poster Summary

A behavioural and modelling study providing complementary evidence that in a semantic category production task:

- ✓ Sensorimotor and linguistic associations are both important, contributing separately and in combination to the frequency and order of responses;
- ✓ Indirect associations between concepts are crucial to explaining participant responses.

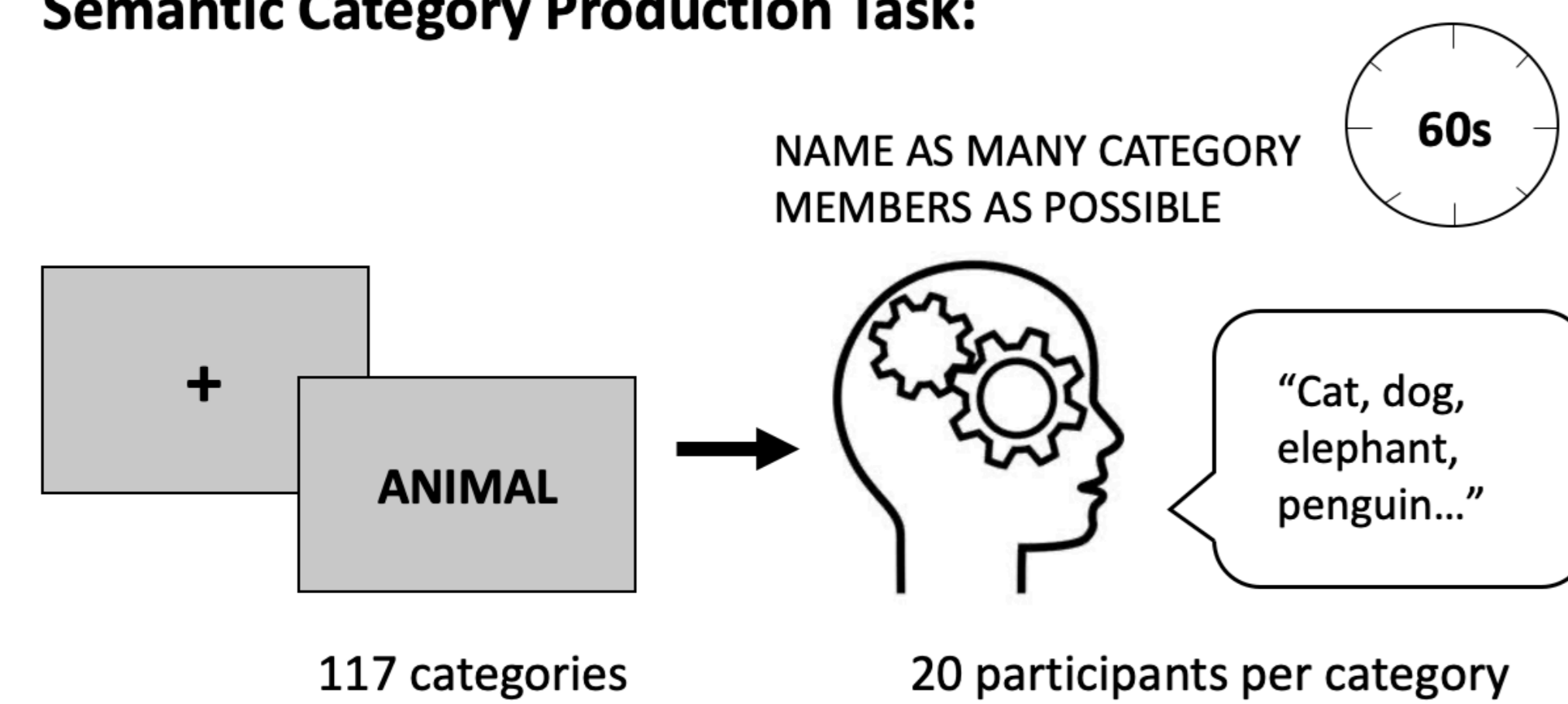
The results shed light on the mechanisms behind the category production task, and conceptual processing more broadly.

References

1. Connell, L. (2018) What have labels ever done for us?: The linguistic shortcut in conceptual processing. *Language, Cognition & Neuroscience*
2. Lynott, D., Connell, L., Brysbaert, M., Brand, J., & Carney, J. (2019). The Lancaster sensorimotor norms: Perceptual and action strength norms for 40 thousand English words. *Manuscript in preparation.*
3. Wingfield, C., & Connell, L. (2019). Understanding the role of linguistic distributional knowledge in cognition: A systematic comparison of tasks, models, and parameters. *Manuscript in preparation.*

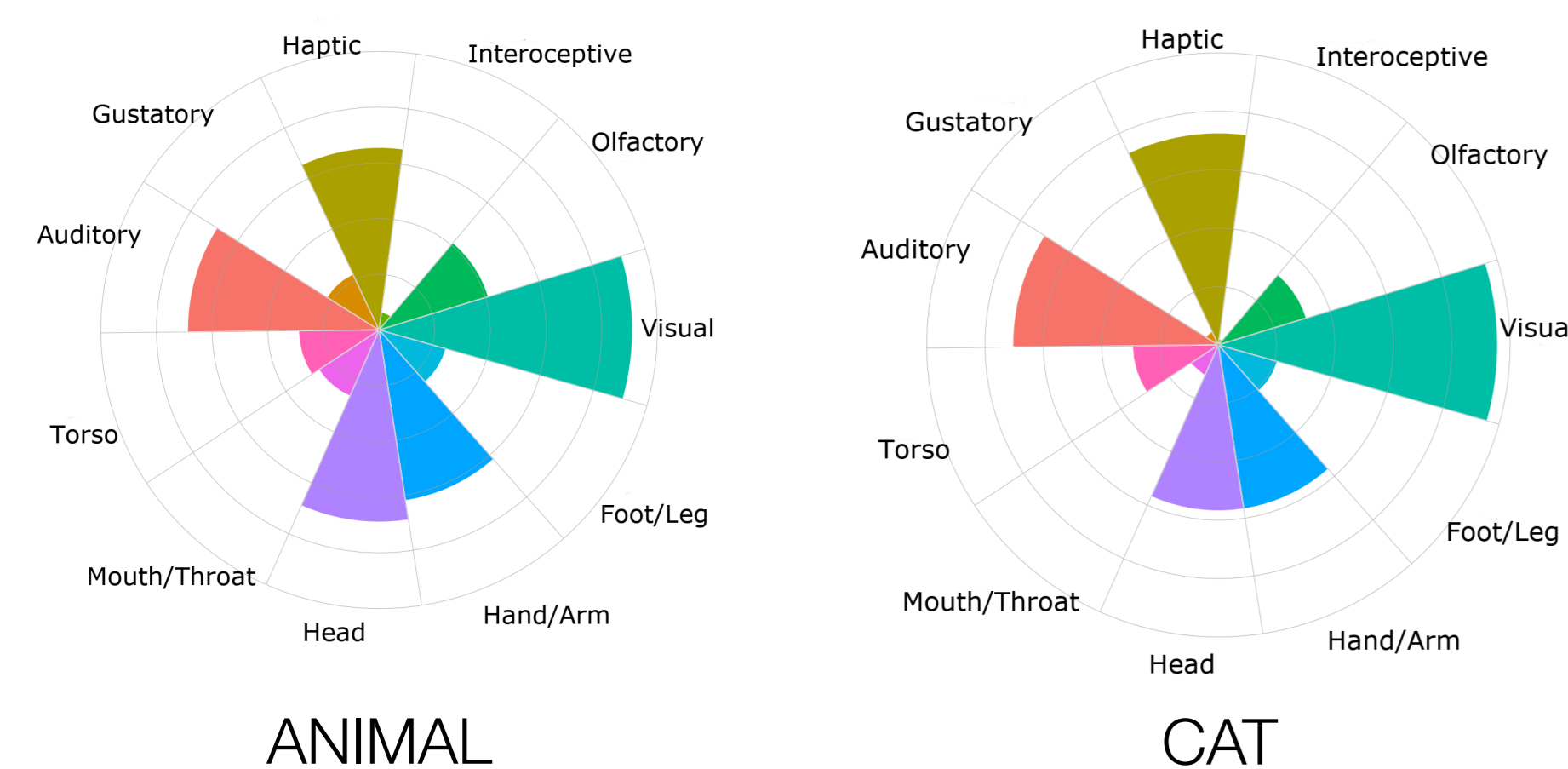
Behavioural Study

Semantic Category Production Task:



Predictor 1: Sensorimotor similarity

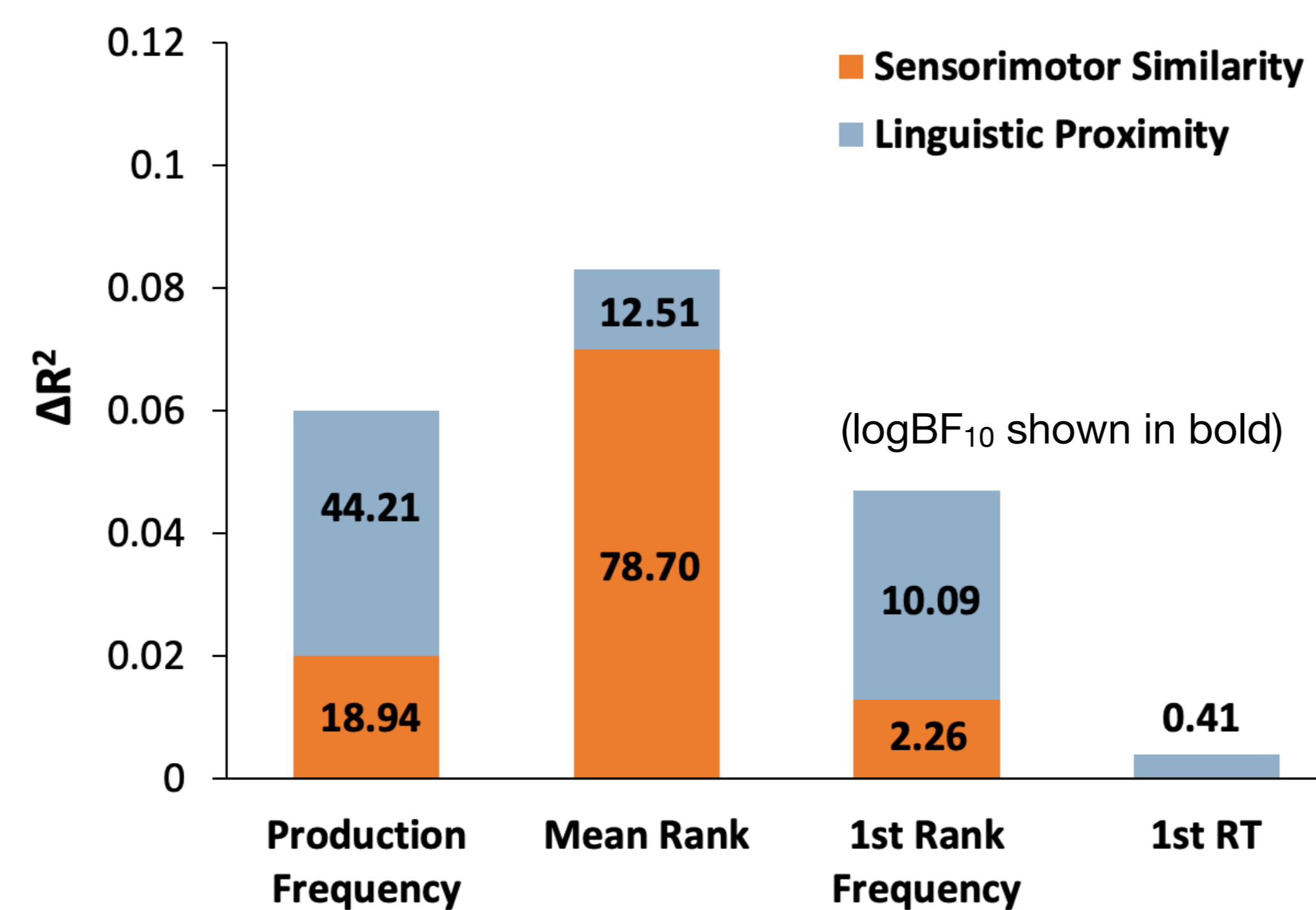
- Cosine distance between category + concept.
- Based on an 11-dimension representation of sensorimotor experience across multiple perceptual modalities and action effectors².
- Higher values = greater similarity.



Predictor 2: Linguistic proximity

- Word statistical co-occurrence (PPMI n-gram, r=5) between category and concept³.
- BBC subtitles corpus.
- Higher values = greater proximity.

Results



Change in R² and corresponding log Bayes Factors from Bayesian hierarchical linear regression analyses. Both regression steps include word frequency (LgSUBTLWF) as part of the null model.

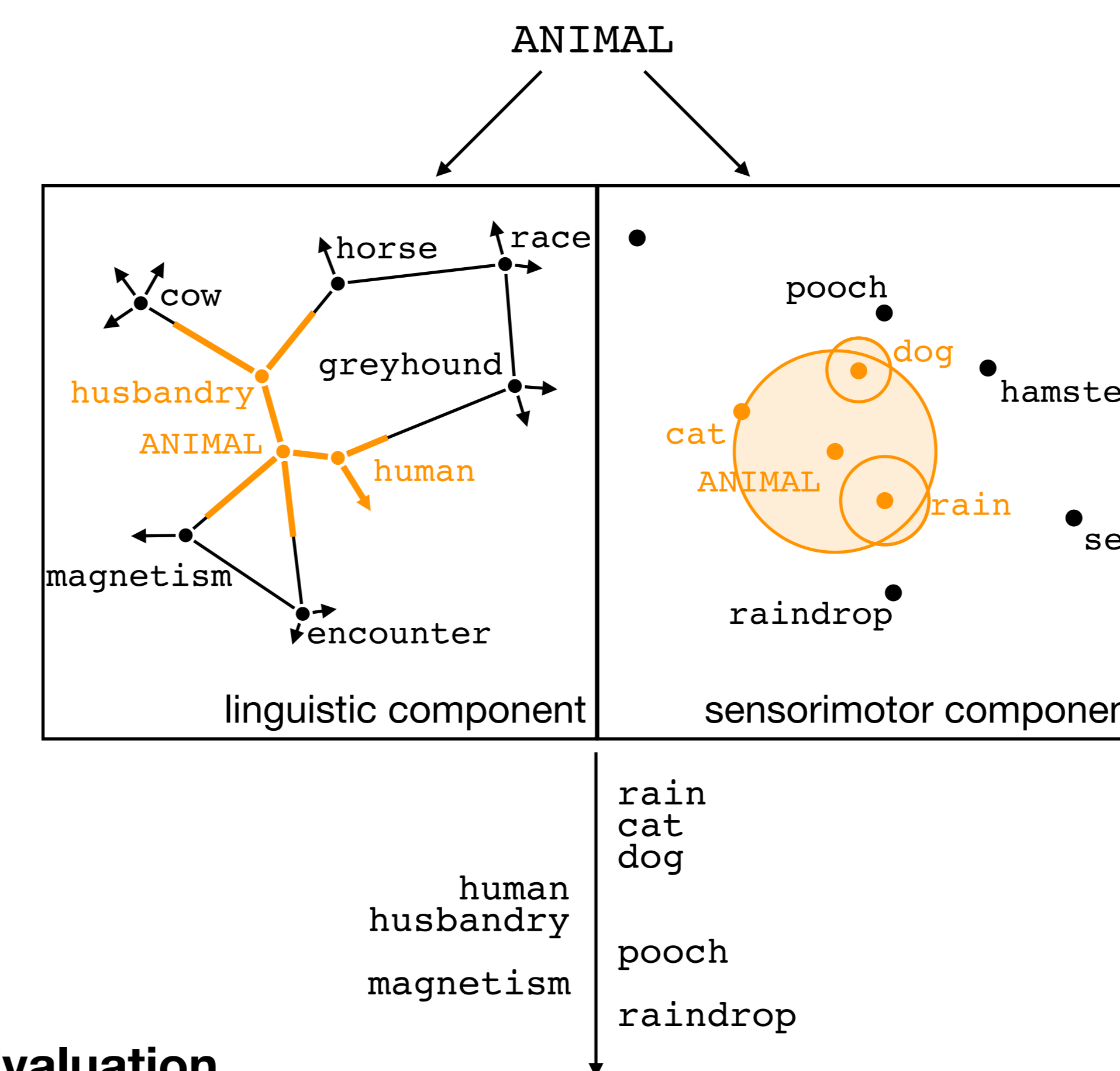
Guidelines for interpreting logBF ₁₀	
> 1.1	Moderate support for H ₁
0	Inconclusive evidence
< -1.11	Moderate support for H ₀

- ✓ Concepts with similar sensorimotor experience to their category and which appeared in similar linguistic contexts were named more frequently and earlier.
- ✓ Category production was better predicted when linguistic proximity was included compared to sensorimotor similarity alone.
- ✓ Equivocal evidence that linguistic proximity predicted first response times (RT).

Modelling Study

Computational model: two-component system

- Linguistic component: activation propagates on graph of linguistic association.
- Sensorimotor component: activation propagates in 11-dimensional sensorimotor space.
- Same stimuli as behavioural study. Track sequence of activations in each component.



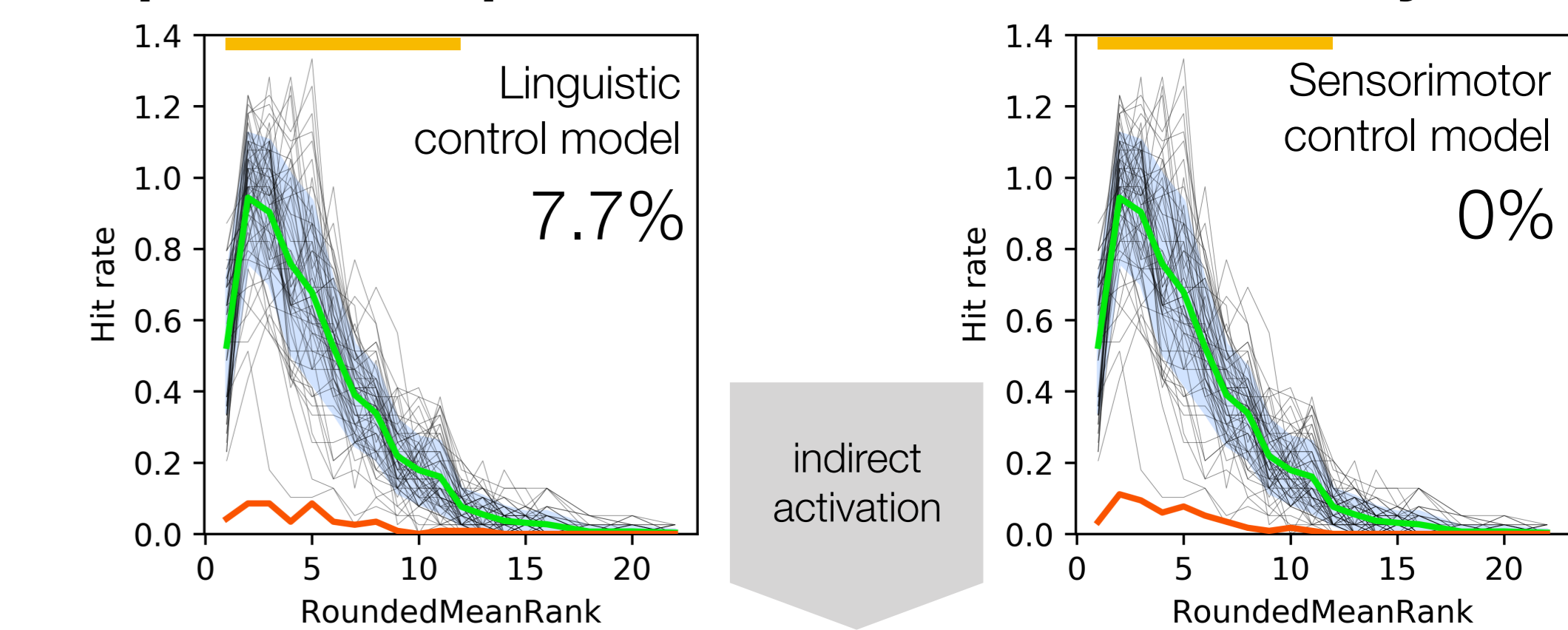
Evaluation

- Model participants' responses by Mean Rank and Production Frequency.
- Fraction of ranked category members produced by individual participants and by model.
- Fraction of ranks where model was within 1SD of participant mean.

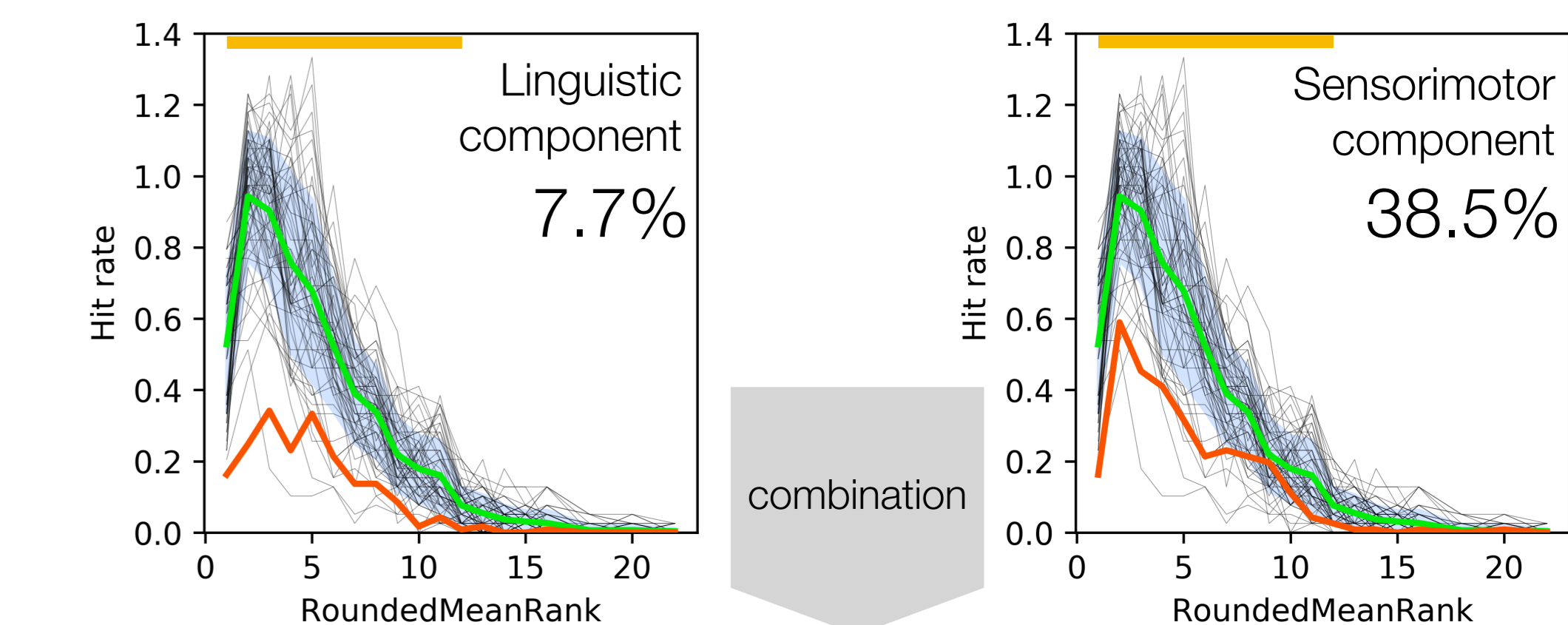
Results

- ✓ Direct associations only lead to poor performance.
- ✓ Allowing indirect activations improved performance for each component.
- ✓ Combining linguistic and sensorimotor information achieved best performance.

Separate components: Direct activations only



Indirect activations allowed



Combined linguistic and sensorimotor

