

Linguistic Distributional Information and Sensorimotor Similarity Both Contribute to Semantic Category Production

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Background

- The human conceptual system comprises grounded **sensorimotor** and **linguistic distributional** information.
- Linguistic distributional information** may provide a computationally efficient way of accessing semantic concepts from memory¹.

Hypothesis: Accessing semantic concepts during a category production task relies on both sensorimotor and linguistic distributional information, but particularly on linguistic distributional information.

Pre-Registration: <https://aspredicted.org/zy4v6.pdf>

Methods

Participants

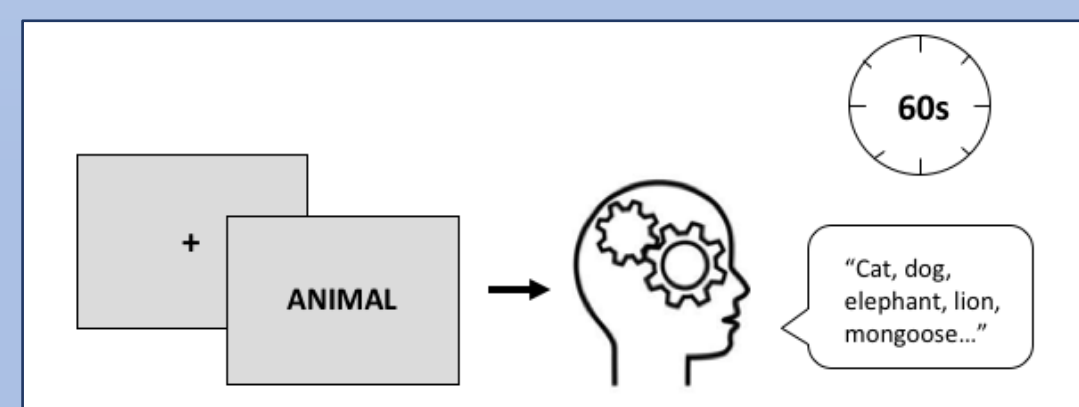
- 60 native English speakers
- Sequential hypothesis testing with Bayes Factors²

Stimuli

- 117 categories**, 3 counterbalanced lists ($N = 20$ per list), e.g.:

Category	Concrete	Living	Animate	Natural	Biological
BIRD	✓	✓	✓	✓	✓
KITCHEN UTENSIL	✓	X	X	X	X
EMOTION	X	N/A	N/A	N/A	N/A

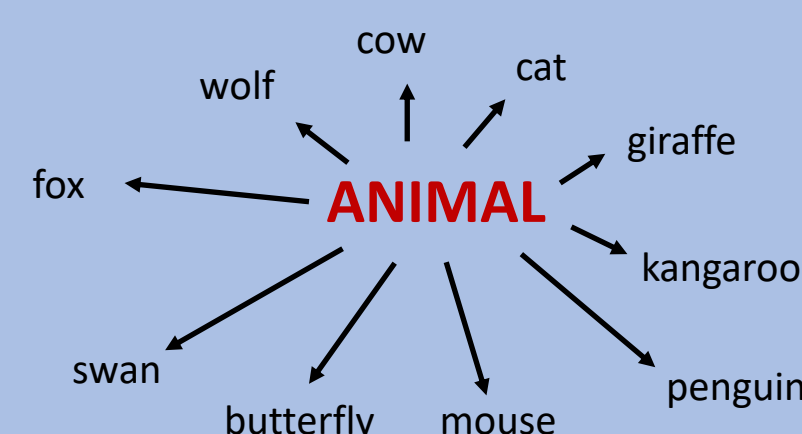
Procedure



Predictor 1: Linguistic Proximity

- Measure of word statistical co-occurrence (PPMI n-gram, $r=5$) between category + concept
- BBC subtitles corpus

*Higher values = greater proximity



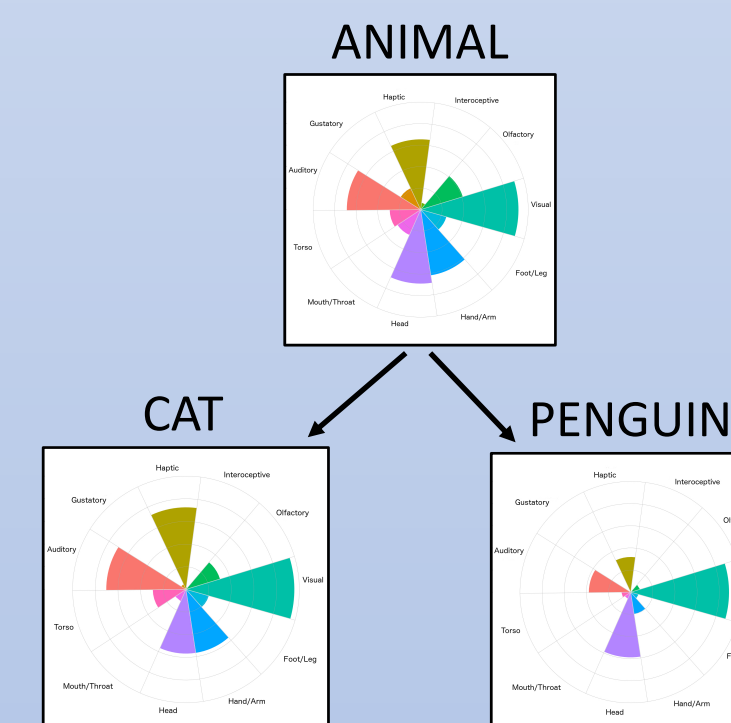
Poster Summary

In a task of semantic category production, measures of linguistic co-occurrence and sensorimotor similarity predicted the order and frequency of responses (e.g., how often “cat” was named as an ANIMAL).

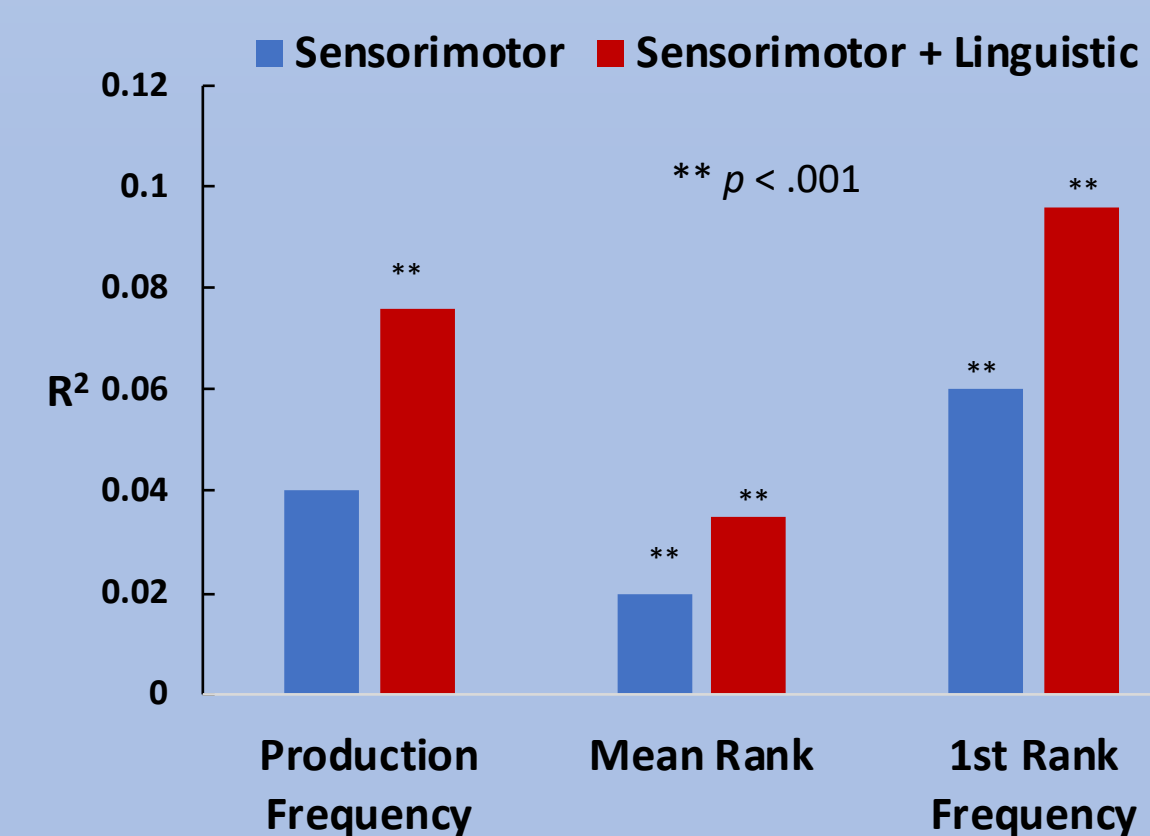
Predictor 2: Sensorimotor Proximity

- Measure of sensorimotor similarity (cosine distance) between category + concept
- Based on sensorimotor ratings for each concept³:

*Higher values = greater proximity



Results 1: Frequency and Order of Responses



Sensorimotor and Linguistic Proximity **both** predicted the frequency and order of responses.

Concepts with **similar sensorimotor strength** to their category, and that appear in **similar linguistic contexts**, were named **more frequently and earlier**.

Strength of Evidence : Bayes Factors (BF)₁₀

Predictor	Production Frequency (N = 2236)	Mean Rank (N = 2236)	1st Rank Frequency (N = 678)
Sensorimotor Proximity ¹	6.22 x 10 ⁶	4.01 x 10 ⁹	405.79
Sensorimotor + Linguistic Proximity ²	2.12 x 10 ¹⁸	154088.09	13506.73

¹ Hierarchical regression: compared to a baseline model of Word Frequency (LgSUBTLWF);

² Compared to a model of Word Frequency + Sensorimotor Proximity

Guidelines for interpreting BF¹⁰

> 3	Moderate support for H ₁
< 0.33	Moderate support for H ₀

Results 2: Response Times

Linguistic proximity predicted first response times

Concepts that appeared in **similar linguistic contexts** to their category were named **more quickly**

But the evidence was inconclusive! (Bayes Factor < 3 > 0.33)

Predictor (N = 1956)	R ²	p	BF ₁₀
Null model (word frequency)	.361	-	-
Sensorimotor	.361	0.633	0.03
Sensorimotor + Linguistic	.363	0.004*	1.43

* $p < .005$

Conclusions

We use **both sensorimotor and linguistic distributional information** when accessing semantic concepts from long term memory in a category production task.

Linguistic information contributes **over and above** sensorimotor information.

Using linguistic distributional information is likely **computationally cheaper** (faster and less effortful) than sensorimotor simulations, providing a linguistic shortcut for completing the task.

References

- Connell, L. (2018) What have labels ever done for us?: The linguistic shortcut in conceptual processing. *Language, Cognition & Neuroscience*
- Schönbrodt, F.D., Wagenmakers, E.-J., Zehetleitner, M., & Perugini, M. (2017) Sequential hypothesis testing with Bayes Factors: Efficiently Testing Mean Differences. *Psychological Methods*, 22(2), 322-339.
- 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*.