Zipf's law of abbreviation and common ground: Past communicative success hampers the re-optimization of language

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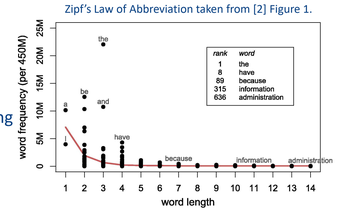
Introduction

Why do words that we use more frequently tend to be shorter in length?

Zipf's Law of Abbreviation taken from [2] Figure 1.



This optimal relationship is called Zipf's Law of Abbreviation (ZLA) [5] and it results from language users maximizing communicative accuracy and efficiency using the least effort possible [2, 4, 6]. ZLA remains stable over time [3], implying re-optimization when topic frequencies within a language change (e.g., information → info since the digital revolution).

What facilitates or hinders this re-optimization?

Common ground has previously been linked to optimality [1].

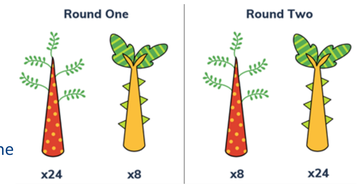
Hypothesis: When topic frequencies change, participants with established common ground will be less likely to re-optimize their language use than participants without common ground.

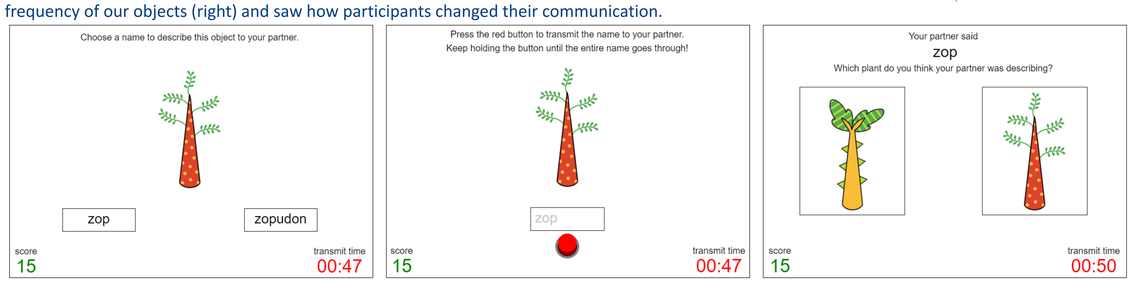
Methods

We replicated and extended [2]. Please see our paper for more info.

Participants:
75 undergraduate students (38 in *no common ground* condition, 37 in *common ground* condition).

Procedure:
Participants learned to associate novel words to novel objects. There was a frequent and a rare object, and two types of words: long and short. Participants played a communication game (below) with a partner, and if following ZLA, should use the short word for the frequent object and the long word for the infrequent object. To simulate a language change, we included a second round where we reversed the frequency of our objects (right) and saw how participants changed their communication.





Discussion

In this experiment, we show that human participants develop ZLA optimal strategies with A.I. communication partners.

Language users are also able to re-optimize their language use after the frequencies of the objects they talk about change. For example: mobile-phone/cell-phone → phone.

Common ground affects the re-optimization process. After topic frequencies change, partners who have a shared history of communicative success may get "stuck" using less optimal systems.

Future research can focus on human-AI interaction in the context of optimality, and optimality in sub-populations that exhibit different topic frequencies.

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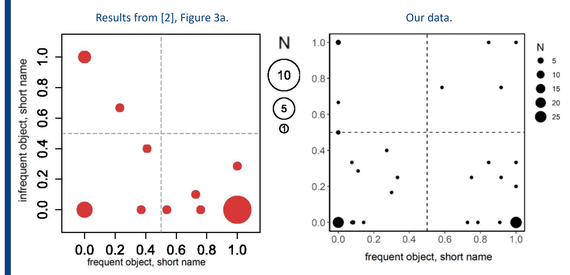
Replication

Does our replication (and methodology) work?

Yes. Graphically, our results are similar. Statistically, our logistic regression model results (DV: short word usage) are also comparable (significant interaction between object frequency and trial, β = 2.026; *SE* = 0.828; *z* = 2.446; *p* = .014).

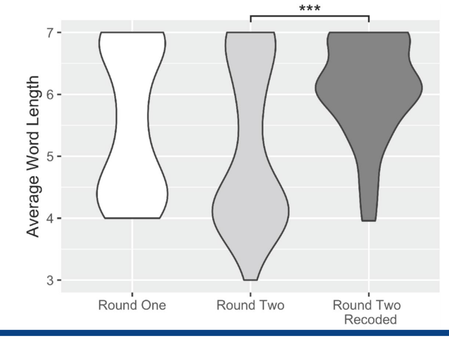
Both graphs depict proportion of trials for short name usage with frequent object (x-axis) vs. infrequent object (y-axis).



Re-optimization

Can people re-optimize their use of language after a language change?

Yes. We compared participants' actual results in round two (light gray) to what their results would have been had they not re-optimized their form-meaning mappings (dark grey), and a paired samples t-test found that this difference was significant (mean of differences = 0.893; *t* = 7.0029(74); *p* < .001).

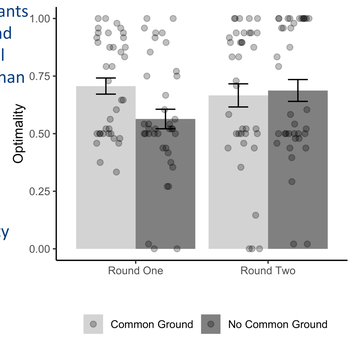


Common Ground

Does common ground hamper re-optimization of language?

Yes. The highest order interaction of the best fitting logistic regression model (DV: short word usage) was a four-way interaction between object frequency, trial, condition, and round (β = -3.165; *SE* = 1.438; *z* = -2.200; *p* = .028).

We found that participants with no common ground produced more optimal systems in round two than they did in round one, whereas participants in the common ground condition did not. However, we were surprised to find differences in optimality between conditions in round one.

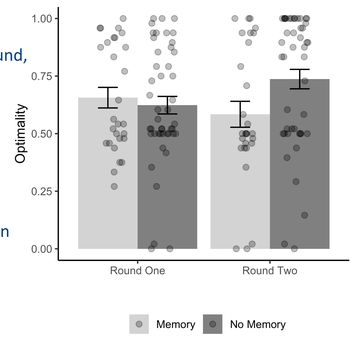


Exit Question

We asked: "**Did you think this robot knew or remembered anything you did during Game 1?**" and had a mixed response (expected responses in gray).

condition	*Yes*	*No*
common ground	16	20
no common ground	12	26

We re-analyzed our data using participants' response to the exit question in place of the common ground condition. The highest interaction was the three-way interaction between frequency, round, and exit question (β = -3.271; *SE* = 0.436; *z* = -7.503; *p* < .001). However, our interpretation remains the same as before: common ground hampers re-optimization in round two.



References

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