Statistical learning of restricted generalizations in an artificial language

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- Successful language acquisition involves generalization: Upon hearing "he rolled the ball/the ball rolled", "she bounced the ball/the ball bounced" […] ; children begin to infer that they can say: I dropped the ball/ The ball dropped.
- Successful language acquisition *also* involves restricting generalization, that is, learning to tolerate exceptions. Children must learn not to say: *Mom, I fell the ball; *Ellie laughed me, *This boy sneezed me (* = ungrammatical sentence).
- **Learnability paradox (Baker, 1979):** How can children tell apart ungrammatical sentences (*He fell the ball) from grammatical sentences not heard thus far (I dropped the ball)?

(1) Under the ***entrenchment*** hypothesis, overgeneralizations (e.g., *He fell the ball) are **blocked by repeatedly hearing the verb** in question in sentences such as "The ball fell", "The boy fell", "He made the ball fall", "Careful not to fall" etc.
(2) Under ***statistical pre-emption*** (Goldberg, 2019), **only synonymous sentences block** overgeneralizations: frequently hearing sentences such as, e.g., "I made the ball fall".

- To date, little work has pulled apart the effects of pre-emption and entrenchment. This is partly because these types of frequency (overall frequency of a verb vs. frequency of its most synonymous construction) are often highly correlated in natural languages.
- Possible to control for this 'confound' in an artificial (experimenter made-up) language which allows precise control over frequency and other linguistic aspects (Samara et al. 2017).

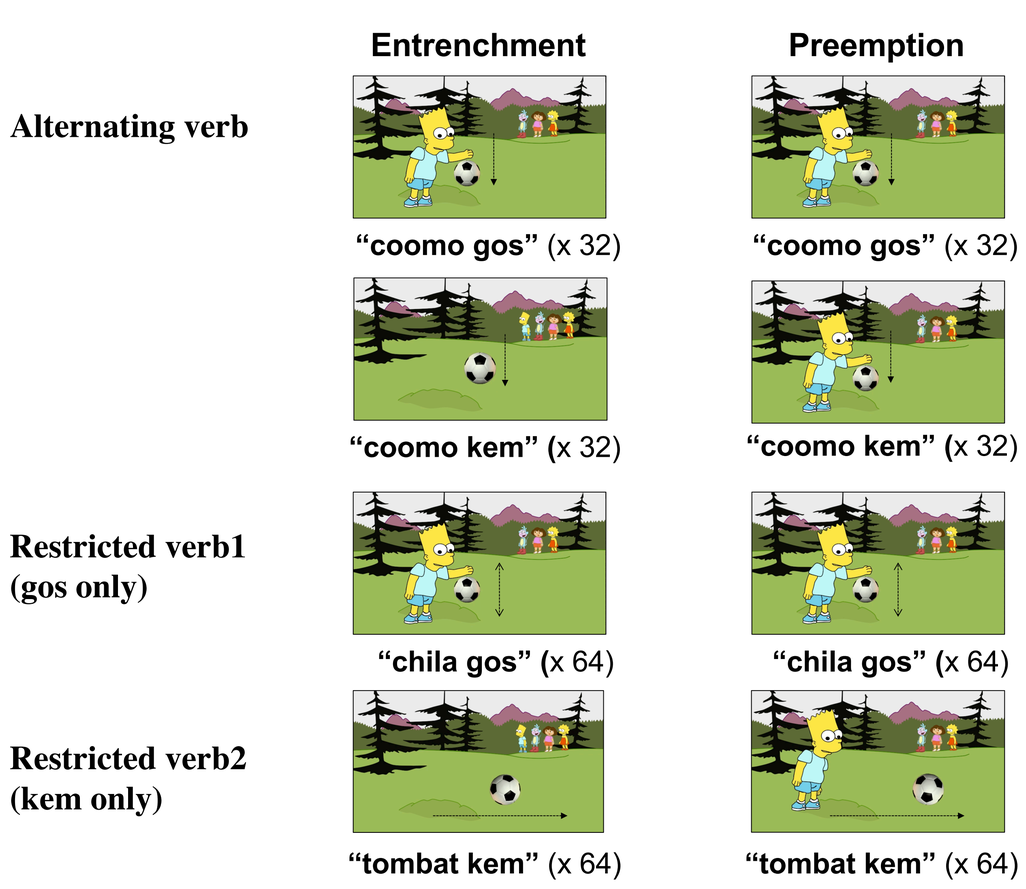
Artificial Language learning study

Participants: 80 native English speaking adults recruited via Prolific Academic. They are told that they will learn to speak like "Freddie" the frog

The language:
- 3 training verbs (chila = bounce; tombat = roll; coomo = drop) + extra verb restricted for testing (panjol = spin)
- 2 particles: gos, kem
- Sentences = verb followed by 1 of 2 particles, e.g., chila gos; tombat kem

	Entrenchment	Preemption
gos	Verb action performed by an agent e.g. "he dropped the ball"	Verb action performed by an agent e.g. "he dropped the ball"
kem	Verb action performed intransitively e.g. "the ball dropped"	Verb action performed by an agent e.g. "he made the ball drop"

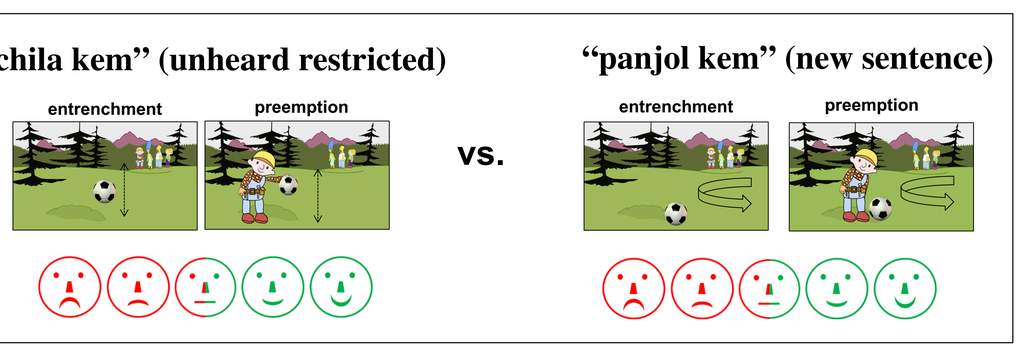
Phase 1: 'Incidental' language training (192 trials)



RQ: How will children judge unheard ('unattested') verb + particle combinations for the restricted verbs when these mean something else compared to the attested combination (**entrenchment**) and when they are nearly synonymous to the attested combination (**pre-emption**)?

Judgment test (phase 2)

- Participants hear sentences produced by Freddie the frog's best friend, Ellie
- View animation (featuring all 3 trained + 1 new verb)
- Told that sometimes Ellie says things 'silly' and they are asked to "rate how 'good' each of her sentence are for a given animation

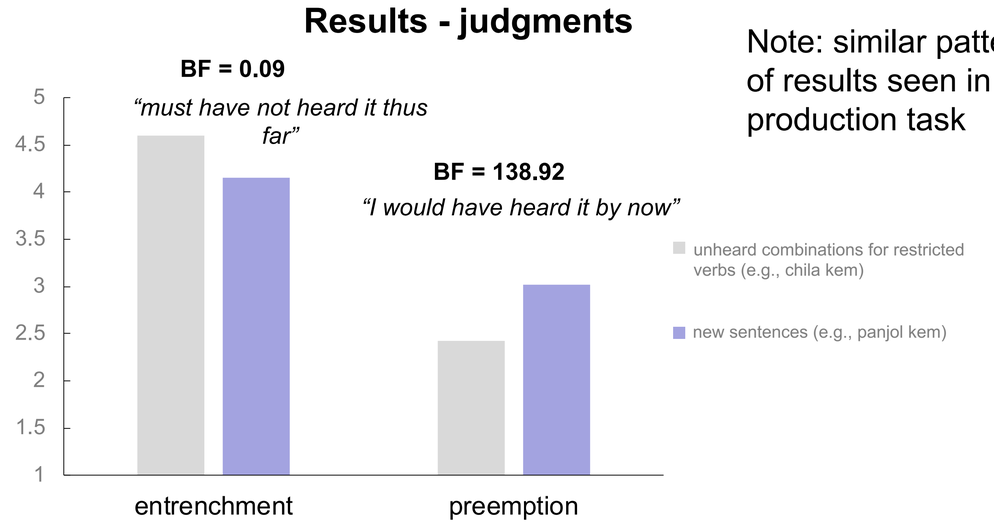


Data analyses

✓ Bayes Factor analyses (Dienes, 2014): Bayesian equivalent of significance testing that tells you how strongly you data support one theory (e.g. H_1) over the null hypothesis (H_0).
- H_0s: Children will equally dislike unattested verb+particle combinations featuring restricted verbs and new sentences.
- H_1s: Children will dislike *more* unattested verb+particle combinations featuring restricted verbs relative to those featuring the novel verbs

✓ **Note that nonsignificant p-value does not tell you whether you have evidence for the null or whether you have no evidence for any conclusion at all. Bayes factors do!**
- BF < 0.33: substantial evidence for H_0
- 0.33 < BF < 3: inconclusive evidence
- BF > 3: substantial evidence for H_1

Results - judgments



Note: similar pattern of results seen in a production task

Discussion & Future work

- Evidence for effect of pre-emption and *no effect* of entrenchment.
- This suggests that only synonymous utterances are relevant in restricting linguistic generalizations.
- Implications for central question in language acquisition research
- **But… we are interested in child language acquisition** (new study preregistered at rpubs.com/AnnaSamara/539534)
- Plan to collect child data on child appropriate analogue:

(1) Training to the language administered over three sessions
(2) Onomatopeic nouns + plural suffixes due to difficulties associated with teaching children verb-argument structure (Wonnacott, 2011)

Currently offered as an MSc student project at Human Sciences, Greenwich University. Watch this space!

References: Ambridge et al. (2014). *Language, Cognition and Neuroscience, 29*, 218-243; Baker (1979). *Linguistic Inquiry, 10*, 533-581; Dienes, Z. (2014). *Frontiers in Psychology, 5*: 781; Goldberg (2019*). Explain Me This*. Princeton: Princeton University Press; Samara et al. (2017). *Cognitive Psychology, 94*, 85-114; Wonnacott (2011). *JML, 65*, pp. 1-14.

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