Construction learning relies on usage *and* function

An artificial language learning study

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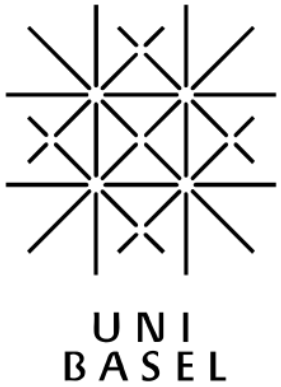

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Usage-based linguistics

- Grammar emerges from usage
- Language acquisition is input-driven
- Speakers are sensitive to statistical information

A wealth of evidence

- Word segmentation can be learned from transitional probabilities (Saffran et al. 1996; Estes et al. 2007)
- Frequent strings of words are processed faster (Arnon & Snider 2010; Gathercole & Baddeley 1993)
- Artificial language learning studies (Hudson Kam & Newport 2005; Wonnacott et al. 2008)

Artificial language learning studies

- "Made-up" language taught to participants with scene-sentence pairs
- The statistical structure of the input can be manipulated, different inputs given to different groups
- Test the role of statistics in language learning

Wonnacott et al. (2008)

- Two constructions with same meaning
  - " Verb Agent Patient " (VSO)
  - " Verb Patient Agent *ka* " (VOS-*ka*)
- Distribution varied across conditions
  - Some verbs occur only in either VSO or VOS-*ka*
  - Some verbs alternate, i.e., they occur in both

Wonnacott et al. (2008)

- Learners depended on the statistics in the input:
  - "Lexicalist" input condition:
    No verb alternated → conservative behavior
  - "Alternating" input condition:
    All verbs alternated → fully productive behavior
  - 33% of verbs alternate in input condition:
    Partially general and partially lexically specific behavior.

Statistics in language learning

- Does language learning *only* consist of gleaning statistical regularities in the input?
- There are learning biases
  - Communicative (Piantadosi et al. 2012)
  - Cognitive: working memory (Gathercole & Baddeley 1993), inductive processes (Griffiths et al. 2010)
- What about the function of constructions themselves?

Our experiment

- Similar to Wonnacott et al.'s but more ecologically valid
  - Their constructions are interchangeable: atypical situation
  - Difference in form often corresponds to some difference in function (Bolinger 1968; Goldberg 1995)
  - E.g., information structure in the dative alternation (cf. Bresnan et al. 2007)

She gave him a book	She gave it to the boy.
?She gave a book to him.	*She gave the boy it.

- We use constructions with a difference in function
- How does this interact with usage?

Our experiment

- Two word order constructions: SOV and OSV
- Difference in information structure:

  OSV order used exclusively with pronouns

'the panda$_{agent}$ pushed the pig$_{patient}$'	intended meaning
the panda the pig mooped	SOV
him the panda mooped	ProSV

- Six novel verbs (e.g., *glim*, *moop*, *wub*) referring to transitive actions (e.g., 'punch', 'push', 'head-butt')

Our experiment

- Two test conditions
  - Lexicalist condition: 3 SOV-only, 3 ProSV-only verbs
  - (Partially) Alternating condition: 2 SOV-only, 2 ProSV-only, 2 alternating verbs
- A third "control" condition (same-meaning condition)
  - Same as lexicalist, but without the difference in information structure (no pronouns)
  - To replicate Wonnacott et al. and check that speakers are able to learn verb-specific behavior

Example of exposure pair

the rabbit the panda norped

Procedure

- Exposure (2 days)
  - 36 sentence-scene pairs, each verb used 6 times
  - Participants asked to repeat each sentence
- Sentence production task
  - Participants asked to describe new scenes with learned novel verbs.
  - Interspersed with distractor tasks (vocabulary questions, forced-choice sentence comprehension)
- Sentence rating task (not reported here; consistent with production)

Production task

- Different questions used to elicit pronouns
  - "What happened here?": neutral context
  - "What happened to the <patient>?": elicits the use of a pronoun for the patient argument
- Two trials per verb, one in each context

Example of production trial (neutral context)

what happened here?

Example of production trial (biasing context)

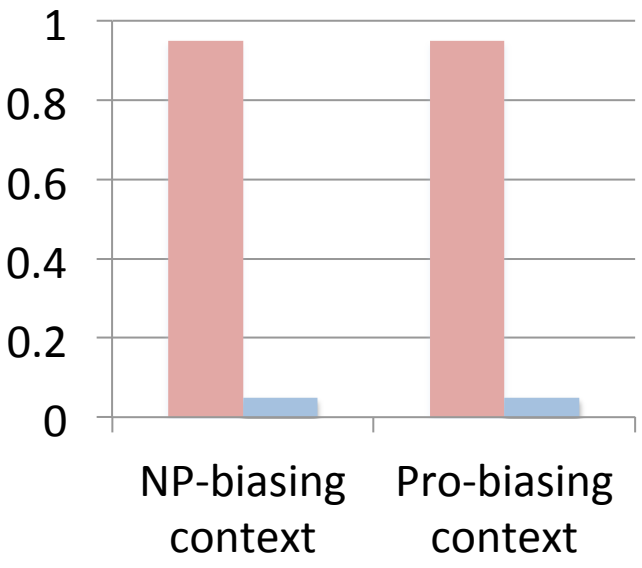
what happened to the panda?

Participants

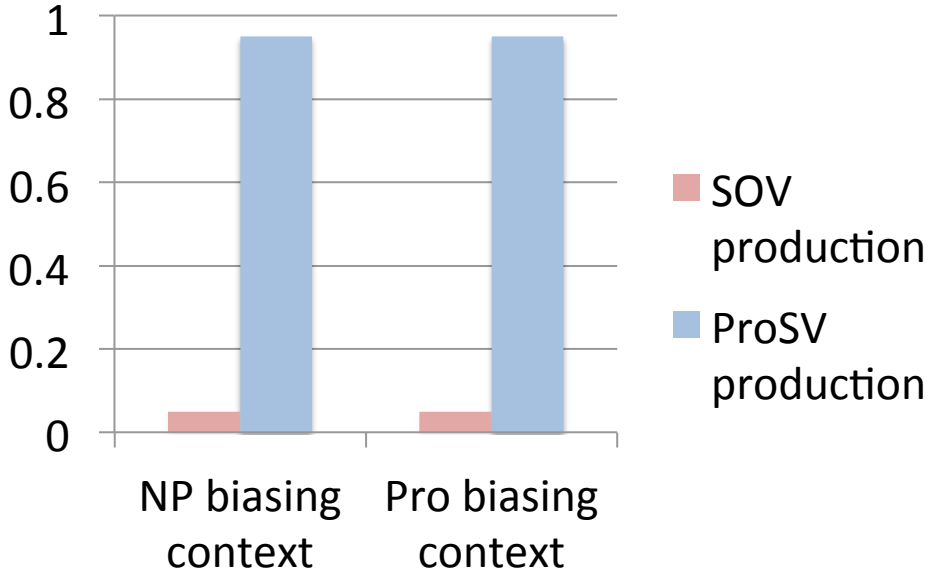
- 64 Princeton undergrads, aged 18-22
  - 24 in the lexicalist condition
  - 18 in the "alternating" condition (2/6 verbs alternate)
  - 12 in the control, same-meaning lexicalist condition

Results

- To what extent do speakers generalize constructions to unattested verbs?
- Hypothetical data: conservative, verb-based behavior



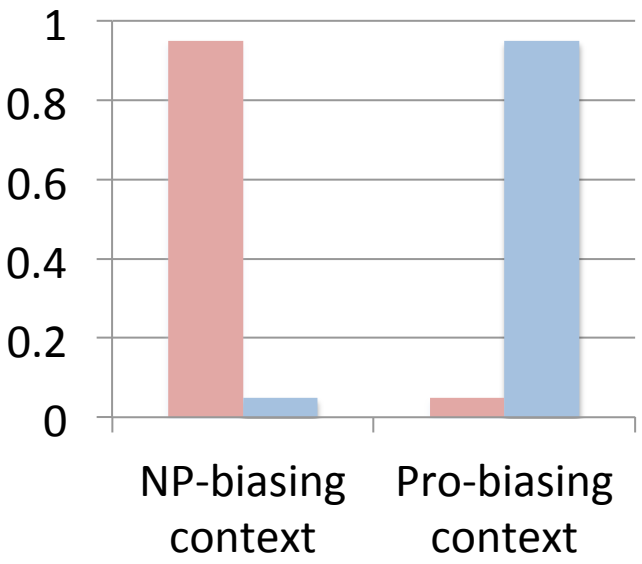
SOV-only verbs in input



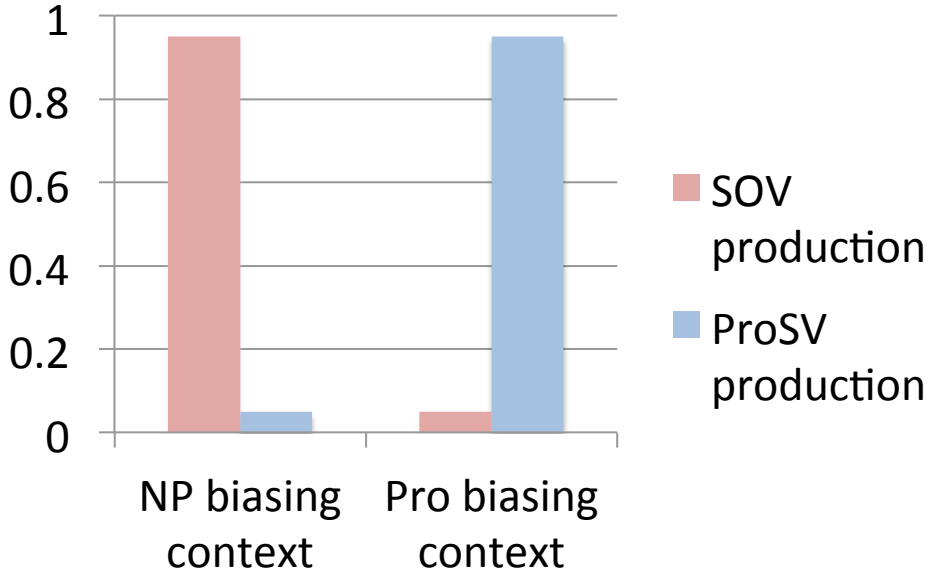
ProSV-only verbs in input

Results

- To what extent do speakers generalize constructions to unattested verbs?
- Hypothetical data: full generalization across verbs

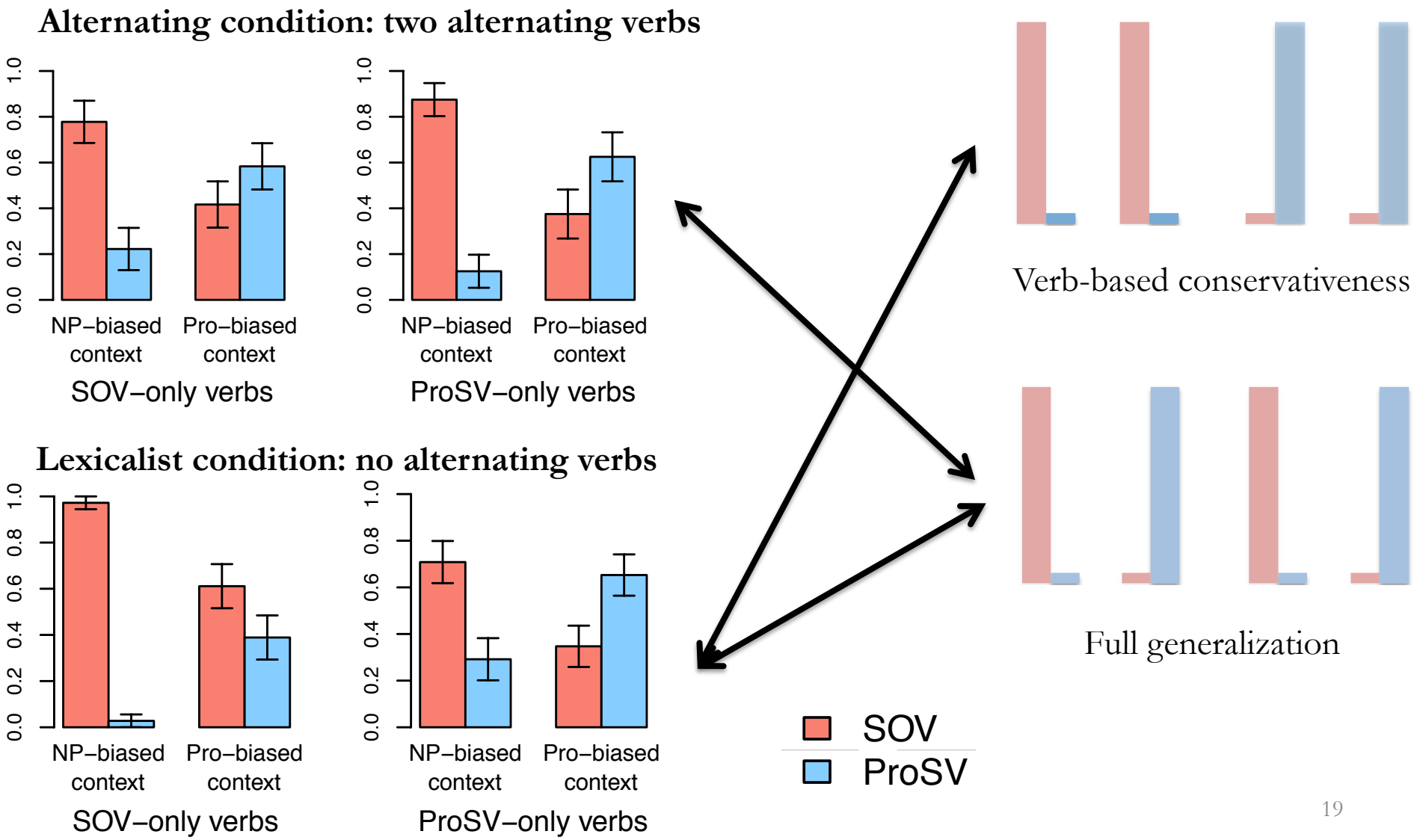


SOV-only verbs in input



ProSV-only verbs in input

Results: alternating vs. lexicalist condition



Mixed effects logistic regression

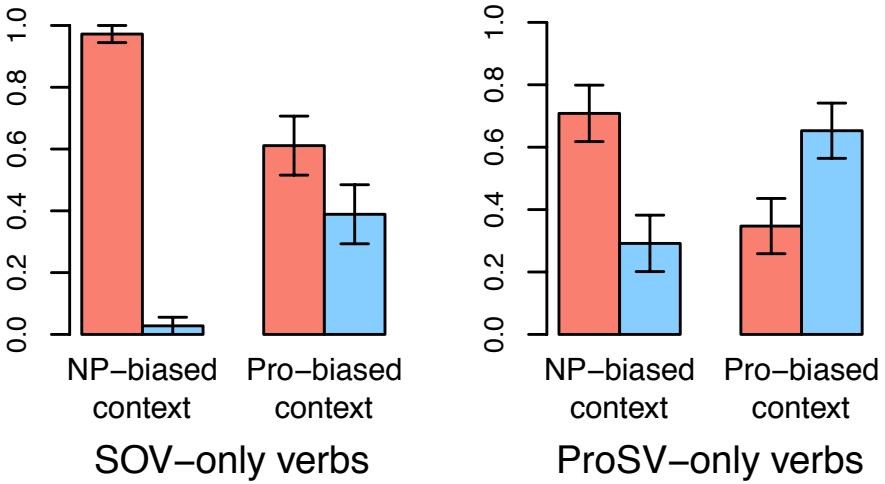
SOV ~ Bias + VerbType * Condition + (1 | Subject) + (1 | Verb) + (1 | Meaning)

	Estimate	**Std. error**	**z-value**	**p-value**
(Intercept)	3.1838	0.3999	7.961	< 0.0001
Bias (Pro)	-2.3499	0.2732	-8.603	< 0.0001
VerbType (ProSV)	-1.3637	0.5118	-2.665	0.0077
Condition (alternating)	-1.8364	0.3286	-5.588	< 0.0001
VerbType (ProSV) : Condition (alt.)	2.0295	0.5424	3.741	0.0002

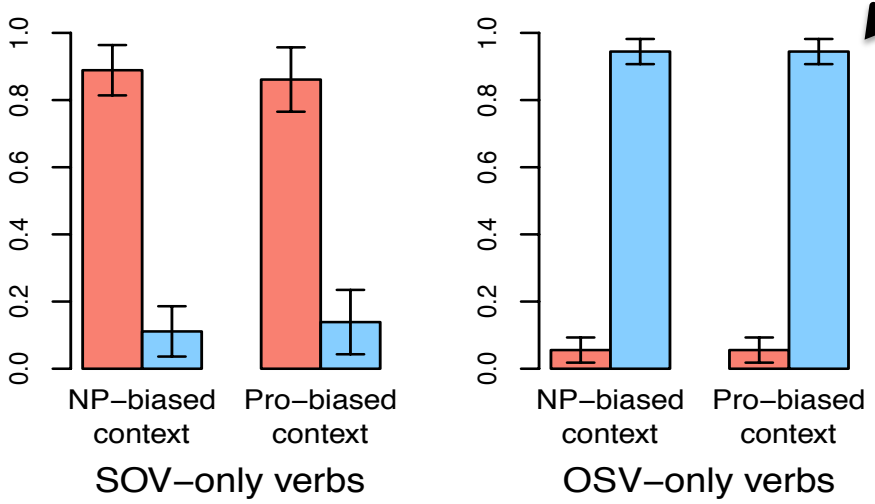
- Main effect of Bias: responses are context-dependent in both conditions
- Interaction between Condition and VerbType: the (conservative) effect of verb type is specific to the lexicalist condition

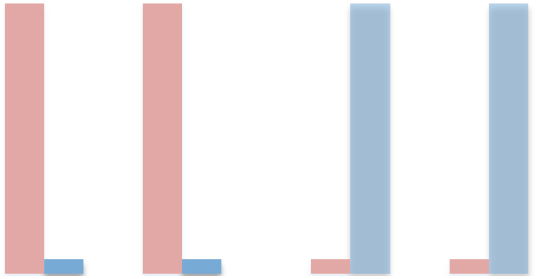
Results: lexicalist vs. same-meaning

Lexicalist: no alternating verbs, different functions



Same-meaning: no alternating verbs, same function





Verb-based conservativeness

Full generalization

Mixed effects logistic regression

SOV ~ Bias * Condition + VerbType * Condition + (1 | Subject) + (1 | Verb) + (1 | Meaning)

	Estimate	**Std. error**	**z-value**	**p-value**
(Intercept)	3.9066	0.6273	6.227	< 0.0001
Bias(Pro)	-2.8129	0.3954	-7.115	< 0.0001
VerbType (OSV)	-2.2545	0.3938	-5.725	< 0.0001
Condition(same-meaning)	-0.5146	1.1023	-0.467	0.6406
Condition(same-meaning) : Bias(Pro)	2.5683	0.8611	2.982	0.0029
Condition(sa-me) : VerbType (OSV)	-5.1771	1.1469	-4.514	< 0.0001

- Condition interacts with both Bias and VerbType
- No effect of context in the same-meaning condition
- Effect of VerbType stronger in same-meaning than in lexicalist condition

Summary

- Tendency for participants to generalize
  - Viz. to use verbs in the contextually appropriate construction
  - They may ignore usage of individual verbs
- This tendency interacts with the input
  - Alternating verbs promote productivity, as in Wonnacott et al.
  - But here: full generalization with only 1/3 alternating verbs
- Sentence rating results in line with production data

Cf. Perek & Goldberg (R&R at *JML*)

Conclusion

- There is indeed an interaction between usage and the function of constructions
- Refinement of the usage-based hypothesis
  - Statistical information is essential to learn both item-specific patterns and general constructions
  - But the communicative functions of constructions determine which dimensions of similarity are relevant to generalizations
  - Item-based constraints are less relevant when other dimension is available

Thanks for your attention!

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