Experimental Approaches to the Evolution of Morphological Complexity

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Overview

1. Studying language change with experiments
2. Artificial language learning
3. Case study on overspecification

Languages result from history

- Language change is a cumulative result of many local actions
- Language as a complex adaptive system - emergent structure self-organized over interactions of various types
- This system can be seen as in balance between and influenced by various different pressures

(Brighton et al. 2005; Christiansen & Chater 2008; Beckner et al. 2009; Mithun SLE-2015)

Language ecology

- Languages adapt to their conditions of use (e.g. Linguistic Niche Hypothesis)
  - Populational niches (e.g. populations with many non-native language learners seem to often be morphologically simpler)
  - Situational niches (e.g. people in mountainous areas or dense jungles incorporate whistle languages to talk over long distances)
- But how does the gradual differentiation emerge?

(Kusters 2003; Nichols 2009; Lupyan & Dale 2010; Winters et al. 2015)

How do languages adapt?

- The particular mechanisms by which languages adapt may vary greatly by circumstance
- Two basic loci for mechanisms:
  - Coordination in local interactions
    - Alignment, accumulation of common ground, variety of situations encountered
  - Limitations through learnability
    - Not all structures can be learnt (by children, by adults, instructed or not)

(Fusaroli & Tylen 2012; Ladd, Roberts, Dediu 2015; Roberts & Winters 2013)

Experiments to investigate language change

- Typological data is sparse and finite
- Given that people have mostly been the same, we can complement it with behavioural experiments
  - What kind of preferences do people have for languages?
    - e.g. Is there a difference in learning of consistent (OV & postpositions) or inconsistent branching languages (OV & prepositions)?
    - e.g. In certain communicative situations (e.g. talking to foreigners) would you prefer analytic strategies instead of synthetic ones?

(Tily & Jaeger 2012; Roberts & Winters 2013)

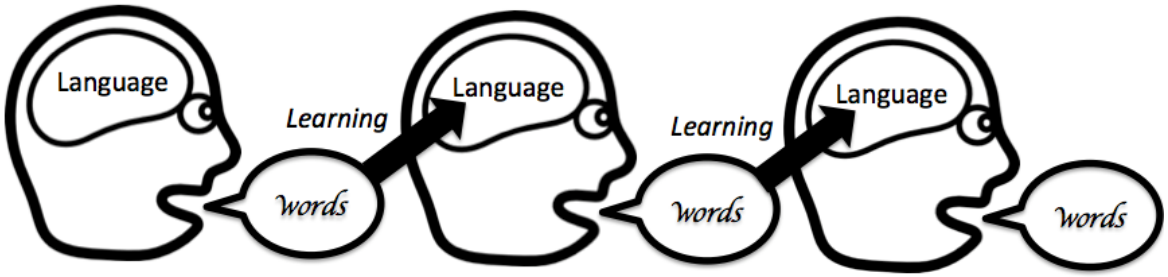
Basic principles of ALL studies

- Artificial language learning (ALL) studies use a miniature artificial language to represent some linguistic facet.
- Language is taught to the participant, where differences may emerge in how they learn it or use it.
- Task must be simple and short enough to be done in the lab by most participants
  - Trying to preserve some ecological validity

(Galantucci & Garrod 2012; Kirby & Scott-Phillips 2012)

Example 1

- Iterated learning (Kirby et al. 2008)

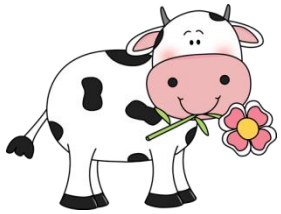


  - Human participants trained on artificial language
  - Output of generation n as input for generation n+1
  - The set of random strings learned by the first generation becomes systematically structured through the transmission of multiple learners, i.e. it develops a morphology
- Allows to identify otherwise invisible biases

(Kirby, Cornish, Smith 2008)

Example 2

- Variation in stimuli (Smith & Wonnacott 2010)
  - Learners were exposed to free variation in a marker in a semi-artificial language
  - Previous studies had shown that this variation is not regularized in adults
  - Chain of learners regularized the learning input
  - Initially free variation became lexically determined by the end of chains



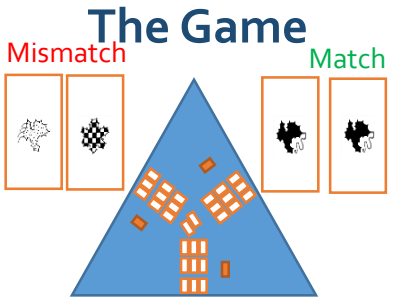
Cow glim tay
Cow glim fip

Giraffe glim tay
Giraffe glim fip

(Kam & Newport 2005, 2009; Smith & Wonnacott 2010)

Example 3

- Suppletion in language contact (Tinits 2014)
  - In groups of 3, each participant was taught one of two ALL contact varieties, which were used to play a game of matching cards
  - Groups with a morphologically simpler minority language (no suppletion) avoided changing to the majority variety
  - In types of neutral contact, simpler varieties may prove more stable?
- Remains an exploration, but can be tested further



The big question

- Why does morphological complexity emerge?
  - Accumulation of arbitrariness (Drift/Maturation)
  - Functional benefits (Selectional pressure)
    - Adaptation to children's learning biases
    - Reduction of production effort (e.g. stem modulation or suppletion instead of affixation)
    - Reduction of processing effort

(Dahl 2004; Wray & Grace 2007)

Overspecification

- Overspecification as an example of morphological complexity
  - „Languages differ in the degree to which they overtly and obligatorily mark semantic distinctions.“ (McWhorter)
  - You use some marker even if it isn’t necessary for communication -> you need to do more work to perform the same task.

(Kusters 2003; McWhorter 2007)

Experimental design

- Could overspecification have cognitive/functional benefits?
- Can this cognitive/functional benefit allow for overspecification to emerge?

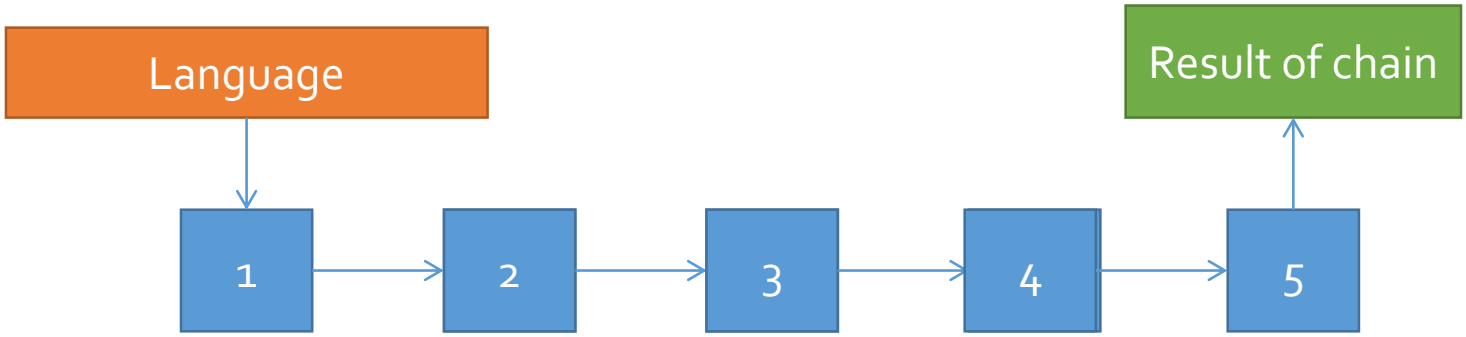
- Imagine a situation where overspecification makes life easier.
- One possible answer: In small communities where information tends to be common in large extent, it may be easier to ignore whether a certain marker is actually required by the context or not.

Study

- Design a pressure for the participants to neglect the relevance of context via distractors.
- Conditions:
    1) Situation without a distractor
    2) Situation with an irrelevant distractor
- The distractor will make it more difficult to observe whether context plays a role at the moment or not.
- Hypothesis: The distractor will bias the language towards a growth in overspecification.

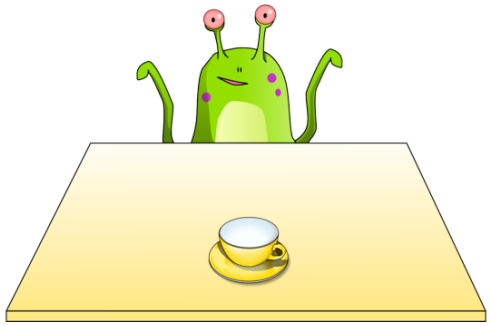
Methods and participants

- Web-based study "Learn an alien language!"
- 120 volunteers recruited via social media
- 12 x 2 chains, 5 participants each
- ~15 minutes per participant

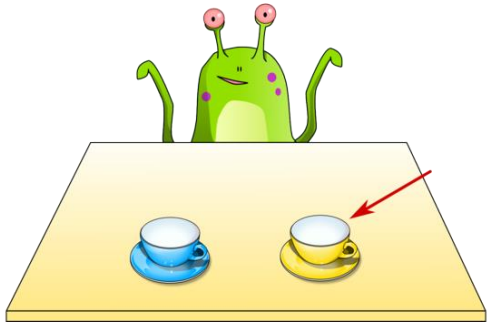


Experimental setup

NO DISTRACTOR CONDITION

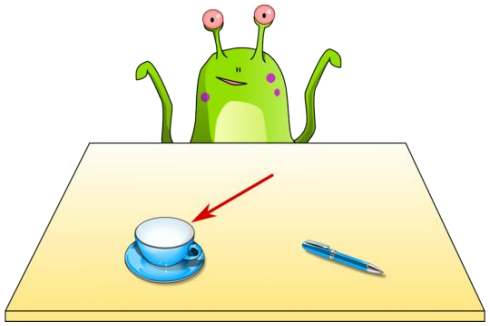


fop



fop li

DISTRACTOR CONDITION



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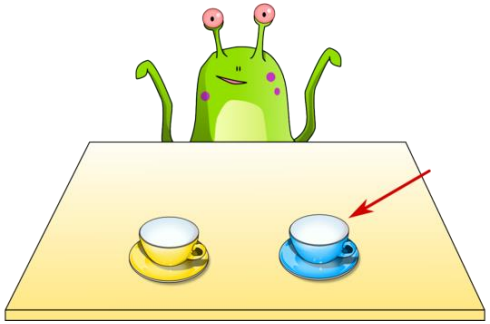


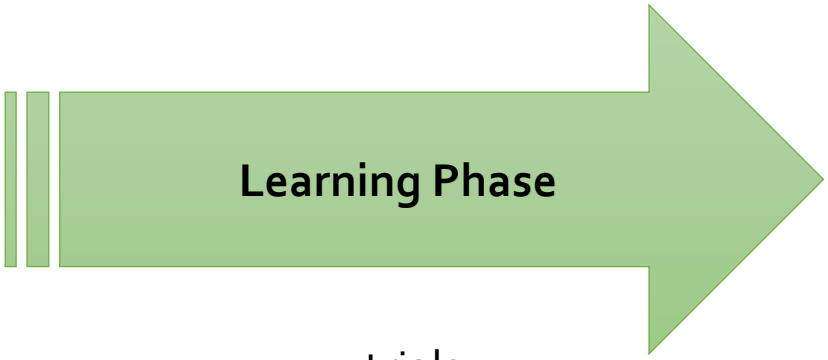
fop pu

Language

- Simple language with a non-obligatory color marker for 1st generation

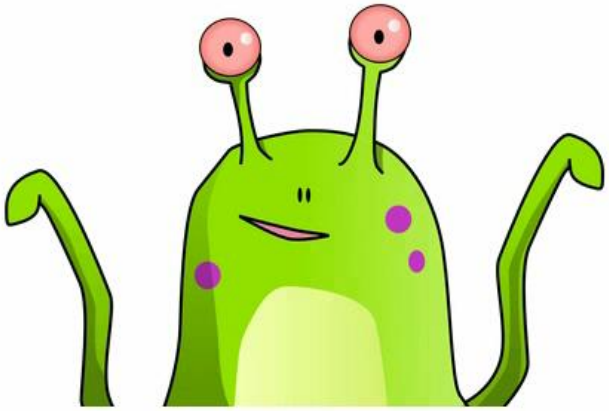
No contrast	Yellow	Blue
meeb	meeb li	meeb pu
fop	fop li	fop pu
kur	kur li	kur pu
yan	yan li	yan pu

Experimental setup



32 trials

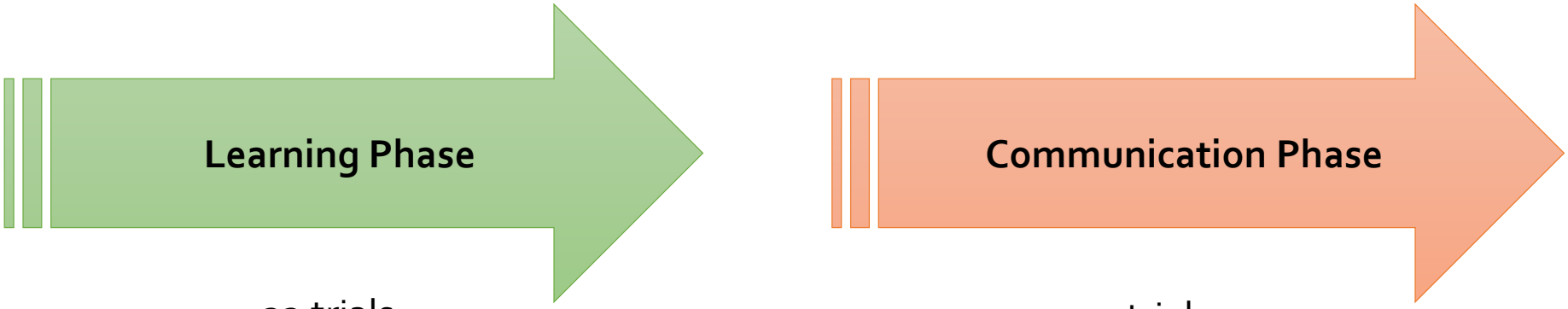
Welcome to our little experiment! It will take about 15 minutes.



This is Ari, an alien from the planet Tsamtrah. Over the next few minutes you will learn to communicate with Ari. You are dealing with a shipment of earth items to Ari which got mixed up on space travel. Ari has restored most of the order, but needs your help in the finishing steps.

Your task is to help Ari in various situations where Ari is unsure which object to pick

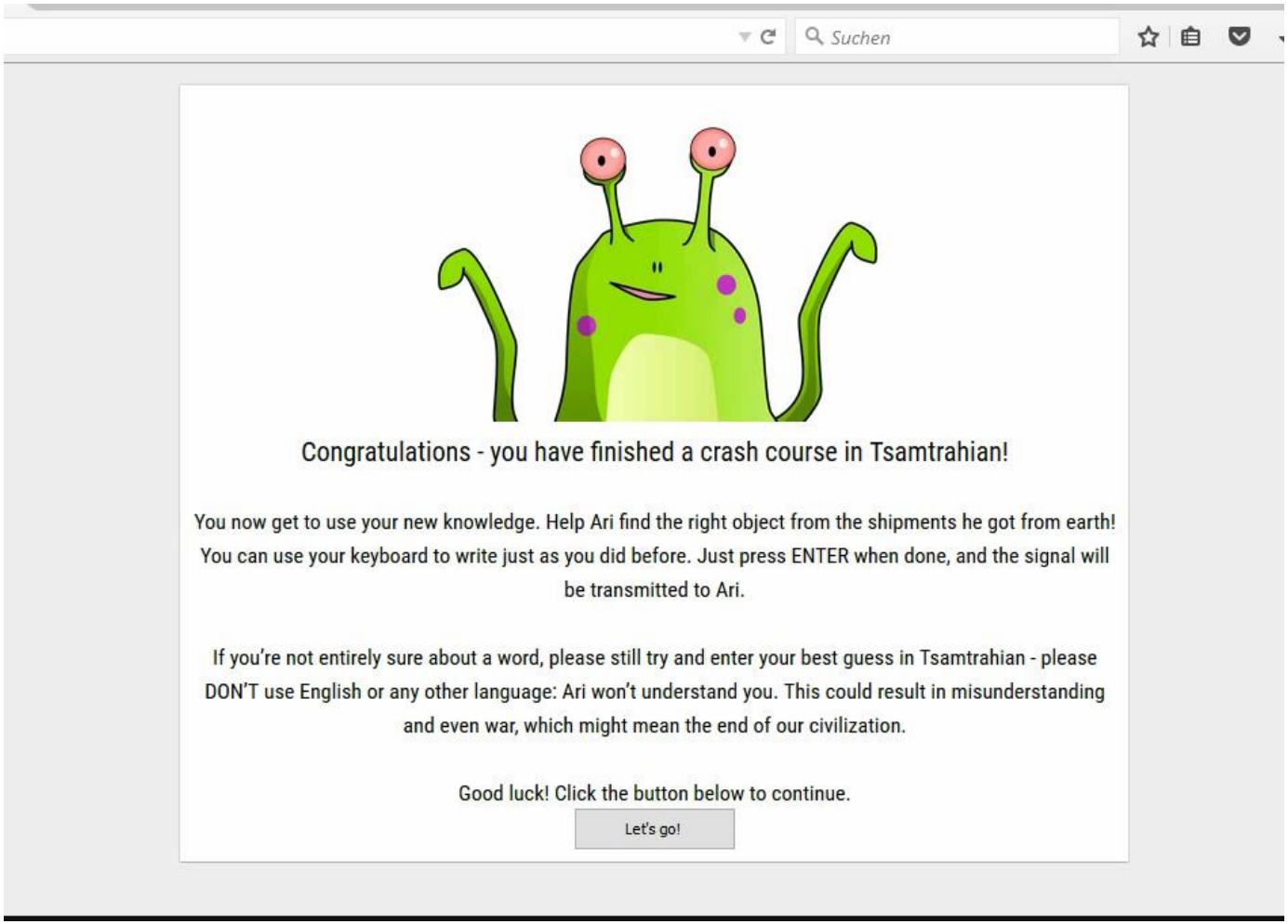
Experimental setup



32 trials

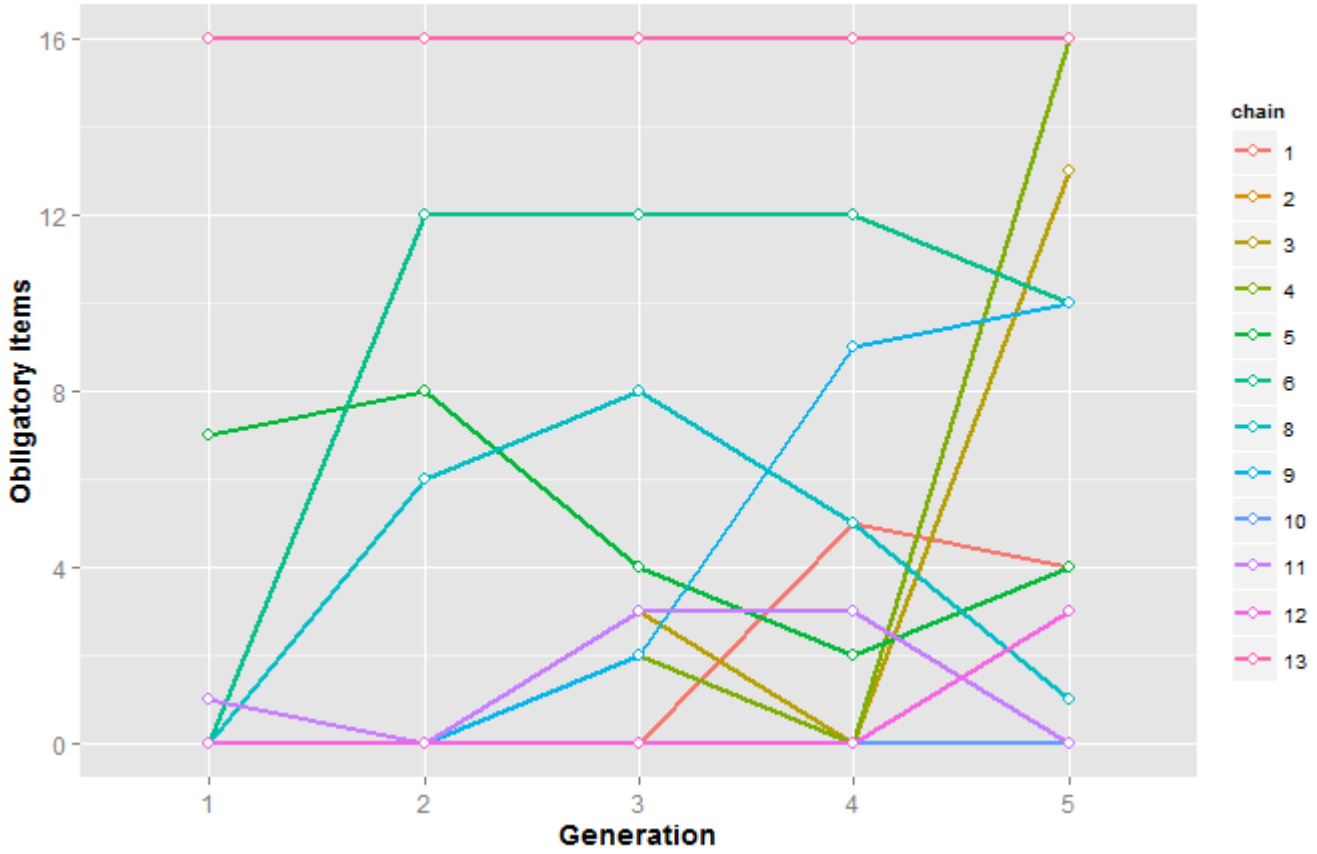
32 trials

+
Questionnaire


Suchen
Congratulations - you have finished a crash course in Tsamtrahian!
You now get to use your new knowledge. Help Ari find the right object from the shipments he got from earth! You can use your keyboard to write just as you did before. Just press ENTER when done, and the signal will be transmitted to Ari.
If you're not entirely sure about a word, please still try and enter your best guess in Tsamtrahian - please DON'T use English or any other language: Ari won't understand you. This could result in misunderstanding and even war, which might mean the end of our civilization.
Good luck! Click the button below to continue.
Let's go!

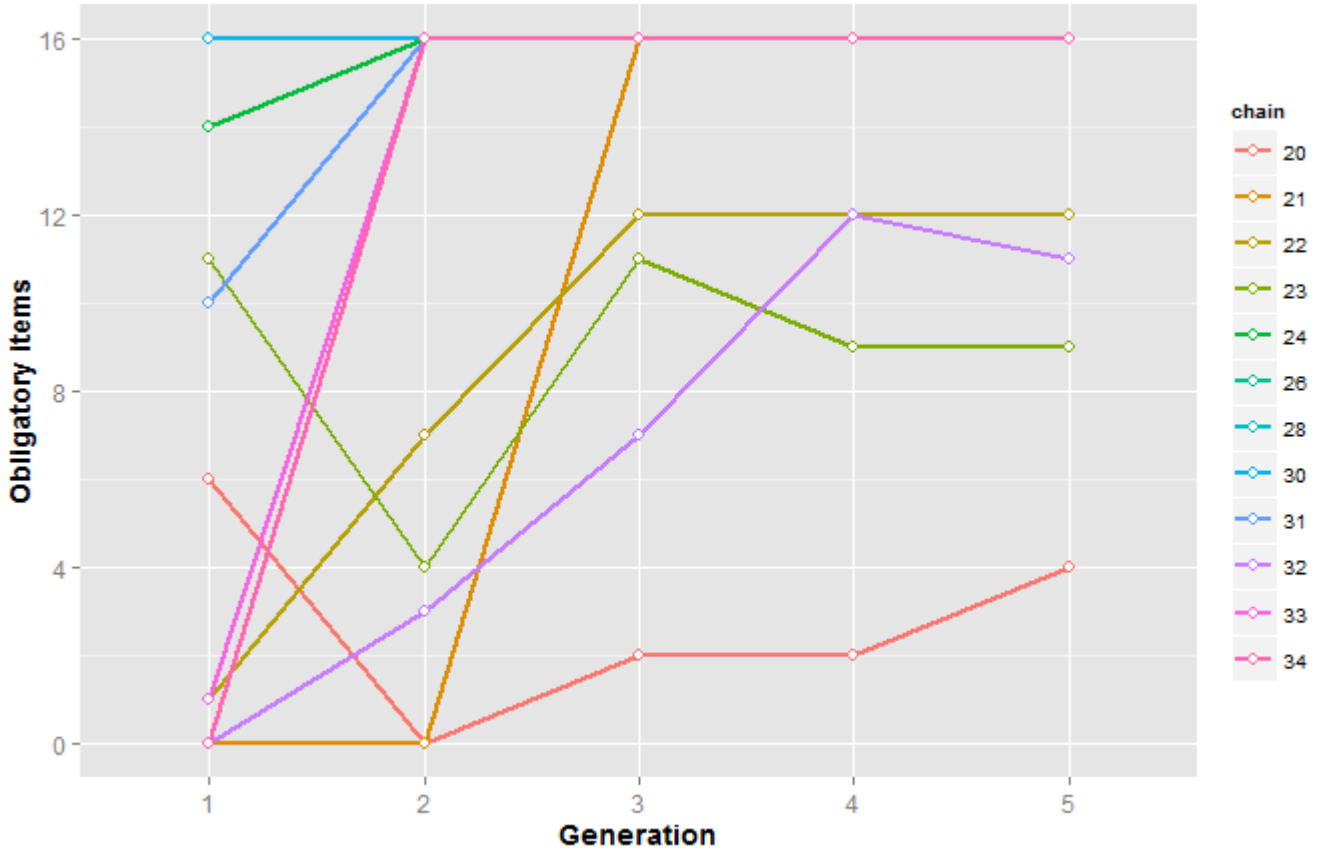
Results

No Distractor Condition



Results

Distractor Condition



How to assess if there are different dynamics at work?

- each chain can be described as a discrete time Markov Chain (sequences with three states)
  $P_{ij} = P[X_{n+1} = j | X_n = i_n , X_{n-1} = i_{n-1} , \ldots, X_0 = i_0] = P[X_{n+1} = j | X_n = i_n], \forall i, j \in Z_+$
- State space: S={1 (non-obligatory), 2 (partly obligatory), 3 (fully obligatory)}
- e.g. 11223

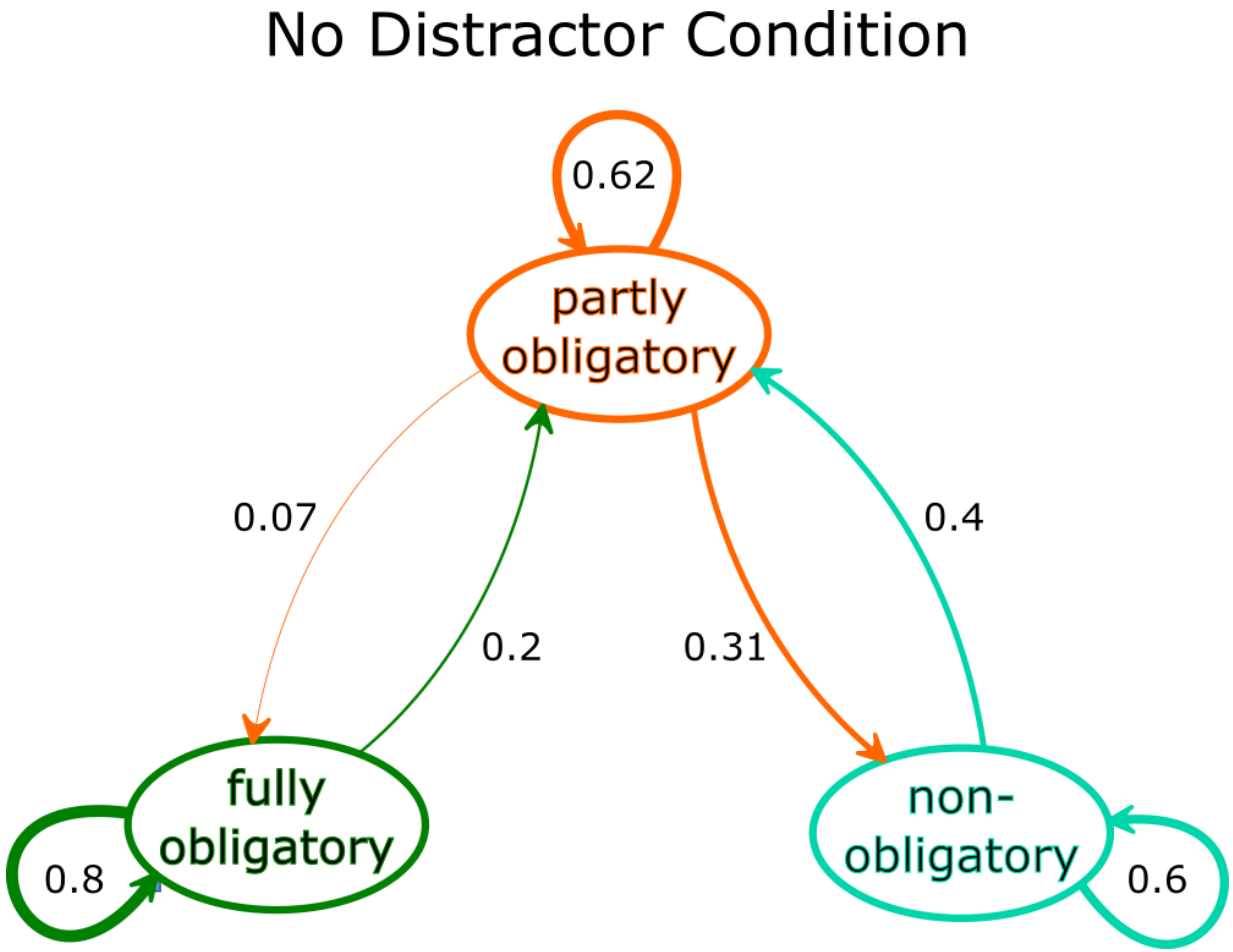
No Distractor Condition

	non-obligatory	partly obligatory	fully obligatory
non-obligatory	0.60	0.40	0
partly obligatory	0.31	0.62	0.07
fully obligatory	0	0.2	0.8

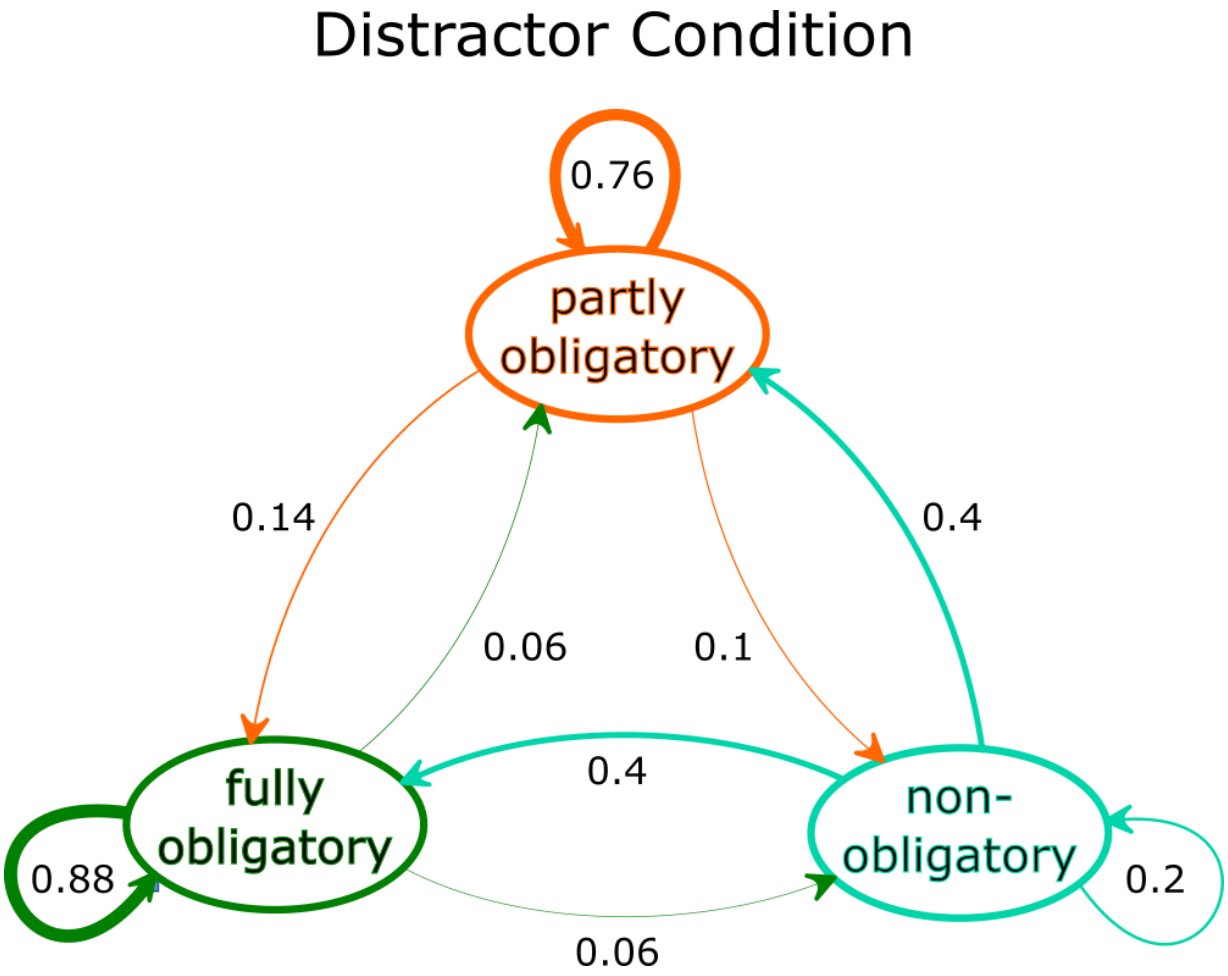
Distractor Condition

	non-obligatory	partly obligatory	fully obligatory
non-obligatory	0.20	0.40	0.40
partly obligatory	0.10	0.76	0.14
fully obligatory	0.06	0.06	0.88

Results


No Distractor Condition
0.62
partly obligatory
0.07
0.2
0.31
0.4
fully obligatory
0.8
non-obligatory
0.6

Results


Distractor Condition
0.76
partly obligatory
0.14
0.4
0.06
0.1
fully obligatory
0.4
non-obligatory
0.88
0.2
0.06

Discussion

- Morphological complexity can emerge during iterated learning, but in both tested conditions.
- There is a greater drive towards morphological complexity in situations with a distractor – overspecified items may be easier to use in these circumstances
- Obligatory marking which allows for context-independent encoding of information may reduce cognitive effort
- Higher frequency of these situations may lead to increase in morphological complexity (cf. Reali et al., 2014)

Conclusion

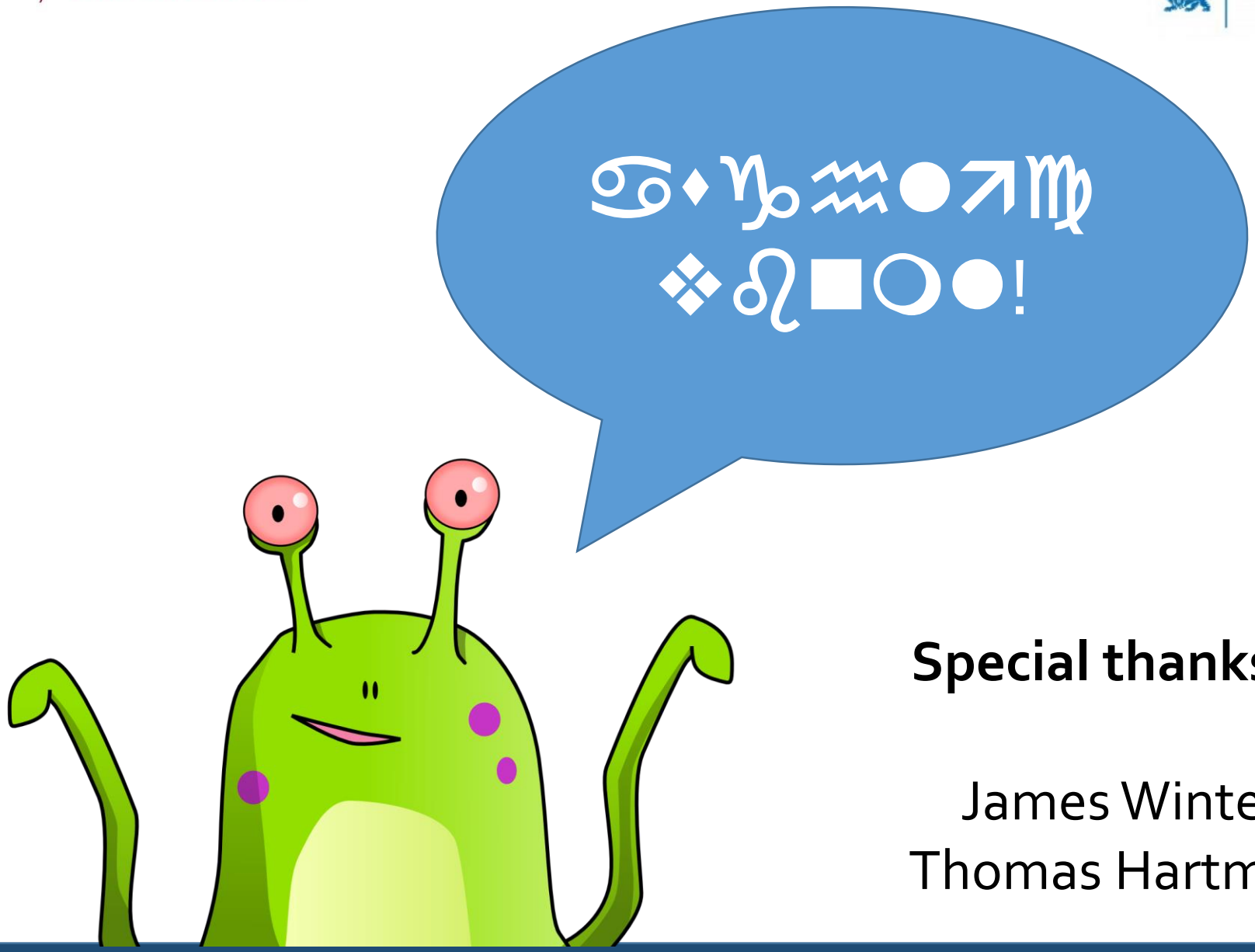
- Small biases in situational contexts can lead to differences in linguistic structure
- Experiments may be a useful way to complement typological studies of language dynamics

Challenges / Limitations

- Using the internet to recruit subjects
- Ecological validity of miniature languages?
- No real(istic) interaction
  - ➢communication game in the lab

Open questions?

- What are the cognitive and communicative benefits of morphologically complex structures?
- What other factors drive the emergence of morphological complexity?
- How can emergence of complexity phenomena be modelled experimentally?



Special thanks to:

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Thomas Hartmann

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