Making *wh*-Questions Bounded: Artificial Language Learning of a Novel Grammatical Marker

Emily Atkinson[1] **& Karen Clothier**[2]

[1]University of Michigan, [2]Johns Hopkins University

Contact: eeatkins@umich.edu

Introduction

Goal of the Study: Investigate the learning (and use) of a novel grammatical marker that generates a specific prediction using an artificial language learning paradigm

Filler-Gap Dependencies

(1) **The book** that the author wrote the article about ___ …

filler gap

Cues to Gap Positions

- Fillers are cues to the presence of a gap with no details about gap position
- *Wh*-agreement = morphological marker on verb that unambiguously indicates the gap position (e.g., direct object gaps in Chamorro [1])

Online Processing

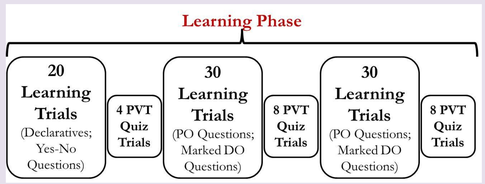
- Active completion of filler-gap dependencies → gap predicted in first possible syntactic position (i.e., the direct object position) without bottom-up evidence (e.g., [2,3])
  - No active completion of the direct object gap in Chamorro when the *wh*-agreement marker is absent [1]

Main Questions: Can participants learn a new cue that is informative about the gap position? What do they learn about this cue, and can they use it in their real time processing?

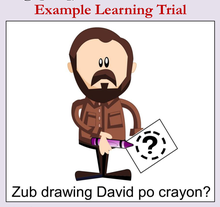
Artificial Language Learning Paradigm

Participants 32 native English speakers from JHU community

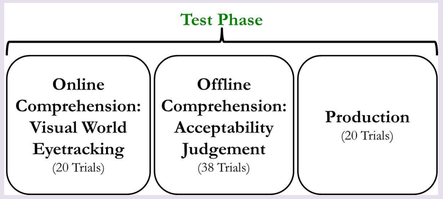
Artificial Language Learning Paradigm (following [4,5])



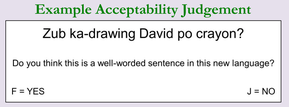
Example Learning Trial



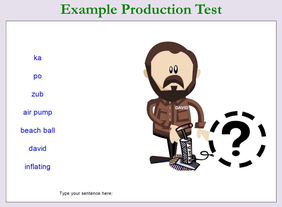
- Participants heard, read, & repeated on each trial



Example Acceptability Judgement



Example Production Test



Artificial Chamorro (AC)

- VSOX word order (same as Chamorro)
- English verbs & nouns

3 novel function words / morphemes:

- **zub** → question marker (equivalent to *what*)
- **po** → preposition
- **ka-** → obligatory direct object gap marker

Example AC Sentences

(2) Declaratives: eating David cake po fork.
'David is eating the cake with the fork.'

(3) Yes-No Questions: eating David cake po fork?
'Is David eating the cake with the fork?'

(4) Prepositional Object (PO) Questions: zub eating David cake po __?
'What is David eating the cake with?'

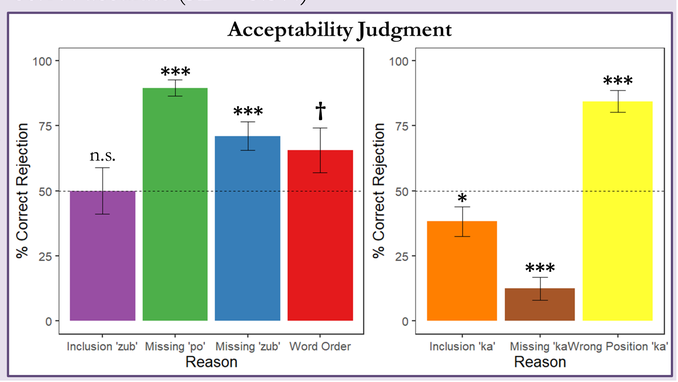
(5) Direct Object (DO) Questions: zub **ka-**eating David __ po fork?
'What is David eating with the fork?'

Results: Offline Comprehension

Grammatical sentences = 80.1% accurate (*SE* = 3.3%)

Participants learned the word order as well as the meaning of **zub** & **po**

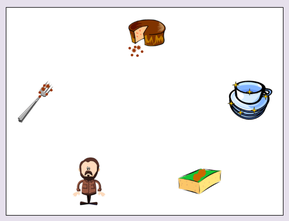
- Learned the position of **ka**, but poor at rejecting incorrect uses & noticing when it is missing from required contexts



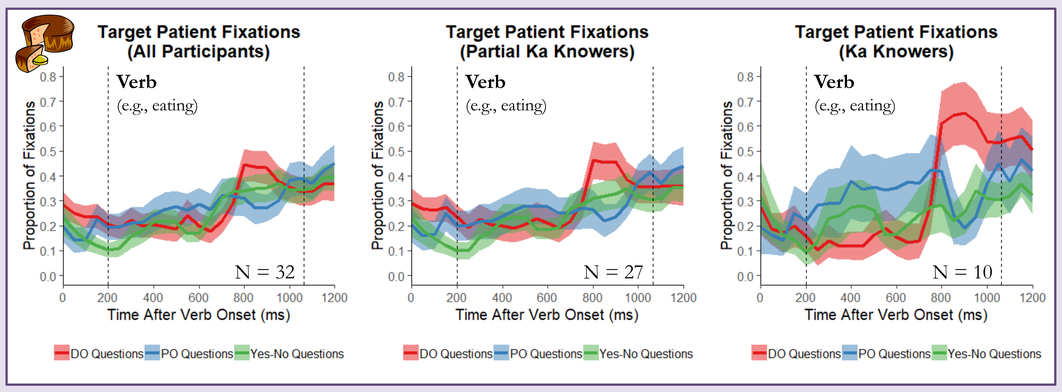
Results: Online Comprehension

Design Question-after-story design [3]

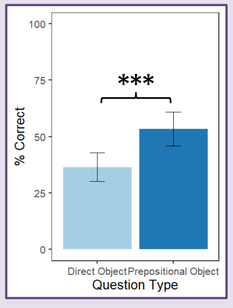
- 15 stories; AC question types (5 each)



Eye Tracking EyeLink 1000 Remote eye tracker (SR Research, Toronto, ON)



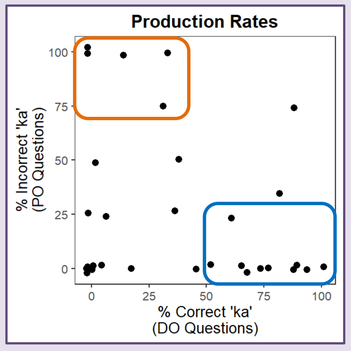
Results: Production



Participants that produced ≥ 1 correct DO question (N = 22) → 53% accuracy (Mean = 8.5/16; Median = 9/16)

How often is agreement marker misused?

- Of incorrect ***DO questions***, 56.2% only wrong because **ka** is missing
- Of incorrect ***PO questions***, 42.9% only wrong because **ka** is included



DO Questions: 12 participants use **ka** correctly ≥ 50% of their productions

PO Questions: 23 participants use **ka** incorrectly ≤ 25% of their productions

- **10 participants** at the intersection
- **5 participants** derived ***opposite*** interpretation

Discussion & Conclusion

Main Findings Participants learned the meaning of a *wh*-agreement marker with limited exposure, but this knowledge is somewhat unstable as they are poor at rejecting incorrect usages of the marker & demonstrate variable production rates.

Significance

New grammatical markers ***are learnable*** from limited input

- ~ 1/3 of participants demonstrated appropriate knowledge in their productions
- But, some participants derived opposite interpretation

Not good at using this knowledge to generate acceptability judgments

- Poor at rejecting incorrect uses of the marker & recognizing when it is absent

Evidence of ***immediate*** online comprehension effects (see also [8])

- DO & PO questions treated differently
  - Active gap filling …delayed in DO questions
    …diminished in PO questions
- Greater effects for **ka** knowers → participants that use marker appropriately
  - Some transfer of processing routine in PO questions
  - Stronger response to presence of marker

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[1] Wagers, M., Borja, M.F., & Chung, S. (2015). The real-time comprehension of WH-dependencies in a WH-agreement language. *Language*, *91*(1), 109-144. [2] Stowe, L. E. (1986). Parsing WH-constructions: Evidence for on-line gap location. *Language and Cognitive Processes*, *1*(3), 227-245. [3] Atkinson, E., Wagers, M.W., Lidz, J., Phillips, C., & Omaki, A. (under review). Developing incrementality in filler-gap dependency processing. [4] Clothier, K., Satoshi, N., Ono, H, & Omaki, A. (2017). *Cross-situational learning of novel anaphors*. Paper presented at CogSci 2017. London, UK. [5] Culbertson, J., Smolensky, P., & Legendre, G. (2012). Learning biases predict a word order universal. *Cognition*, *122*, 306-329. [6] Estes, W.K. (1964). Probability learning. In A.W. Melton (Ed.), *Categories of human learning* (pp. 89-128). New York: Academic Press. [7] Hudson Kam, C.L. & Newport, E.L. (2009). Getting it right by getting it wrong: When learners change languages. *Cognitive Psychology*, *59*(1), 30-66. [8] Pozzan, L. & Trueswell, J. (2015). Revise and resubmit: How real-time parsing limitations influence grammar acquisition. *Cognitive Psychology*, *80*, 73-108.