Non-adjacent lexical dependencies in an artificial language prime relative clause attachment biases

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1. Introduction

- Where does the bias in parsing ambiguous relative clauses come from? Is it influenced by the previous statistics people have collected?
- Prior work: Representation of abstract dependencies in language & other domains (e.g. Menon & Kaiser, 2013; Mitchell et al., 1995; Scheepers et al., 2011; van de Cavey & Hartsuiker, 2011).

- What about abstract relations represented through word-level statistical regularities in an artificial language?
- **Research question:** Can adjacent and non-adjacent structures derived from word-level statistics prime the low vs. high attachment preference during the production of relative clauses (RCs)?

- We manipulated the dependencies participants encountered in the priming material
  - Non-adjacent dependency sequences (A_iXC_i) from Gomez, 2002. A **non-adjacent dependency (NAD)** is a three-word sequence such that the first word uniquely predicts the third word, while the second word can vary.
  - This structure models the linear sequence of high attachment in RCs (e.g., *Kevin counted the fans of the singer who were excited*).
- ***Hypothesis***: if abstract relations extracted from lexical statistics trigger syntactic priming, learning the non-adjacent dependency should prime participants to produce more high-attachment relative clause completions than control participants.

- **English RC's** have a default low-attachment bias (e.g., Brysbaert & Mitchell, 1996). Can this be weakened by non-adjacent primes?
- **Prediction:** If non-adjacent lexical-level representations prime dependency formation in RCs, participants should produce more high-attachments after non-adjacent sequences than after adjacent sequences (ACX, and XAC).

2. Experiment Design

- ***STEP 1: Training phase (~20 min)***: Participants (n=50) heard three-'word' strings in an artificial language (adapting stimuli from Gomez'02, e.g. *choon glaik jub*).
  During listening, they answered a question on what word was just played every few minutes.

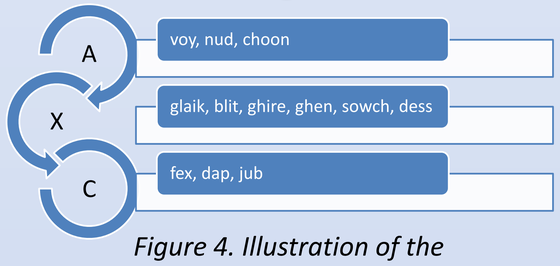


Figure 4. Illustration of the artificial language in Gomez, 2002.

- Between-subjects design, participants encounter different dependencies:
- Non-adjacent group (n=20) was trained on non-adjacent dependencies ($\mathbf{A_iXC_i}$)
- Two adjacent groups (n=10 each) trained on adjacent dependencies ($\mathbf{A_iC_i}$X, and X$\mathbf{A_iC_i}$)
- Baseline group (n=10) trained on random three-word orders with no dependencies.

CrPr	Critical Prime	(voy glaik fex) Is it in the language you heard? • Yes ✓ • No
CrCom	Critical RC Completion	Harry met the doctors of the supermodel who _ • cured cancer (HA) • was skinny (LA)
FlPr	Filler "Prime"	(voy glaik dap) Is it in the language you heard? • Yes • No ✓
FlCom	Filler fragment completion	The waitress revered the funny bartender with the thick moustache although _

- ***Step 2: Test phase (~20 min)***
- Two trial types:

a. hear three-'word' sequence [prime], say whether it's in the language

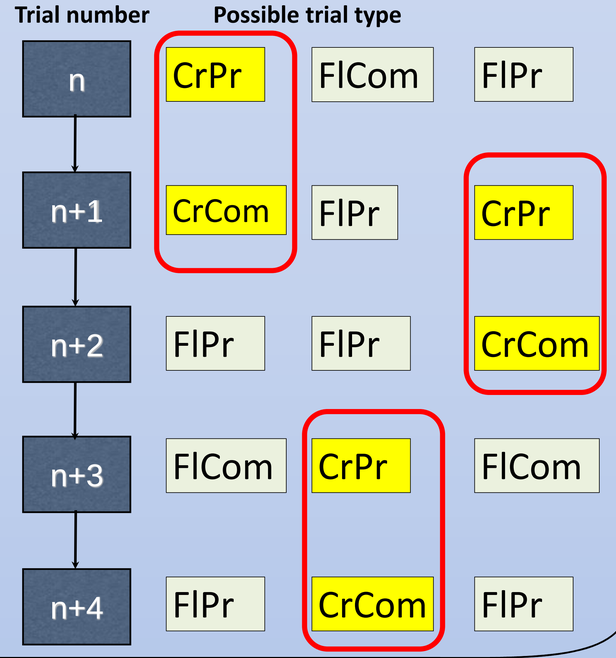
b. write completions for RC fragments

- On critical trials
  - Artificial language prime occurred immediately before RC fragment.
  - Expected answer to artificial language prime: Yes
  - Then complete relative clause fragment
- Sentence fragments on critical trials were ambiguous RC fragments, people wrote continuations:

Kevin counted the fans of the singer who

- **…were really excited (HA)**
- **….was performing that night (LA)**

Test sequence Illustration



3. Results

- **Coding**: RC completions analyzed as **high-attachment (HA)**, **low-attachment (LA)**, or **ambiguous** (coded as missing in Logistic Regression).
- **Successful learning of non-adjacent dependencies:** Above-chance performance in test-phase learning questions ($p<0.001$, Mixed-effects Logistic Regression).
- **RC completions influenced by NAD primes**:
- ***More high-attachment completions in nonadjacent prime group than other 3 groups ($p<0.001$, Mixed effects Logistic Regression) => Fig.1***
- **People who learned a non-adjacent dependency in the artificial language were more likely to produce RCs that attach to the non-adjacent (higher) noun**

➢ compared to people in control conditions (who learned local dependencies or no dependencies)

- People trained with nonadjacent primes do not follow any item-level (Figure 2) or group-level (Figure 3) tendencies to complete a sentence with High Attachment bias with regard to explicit knowledge of Non-adjacent Dependency questions.

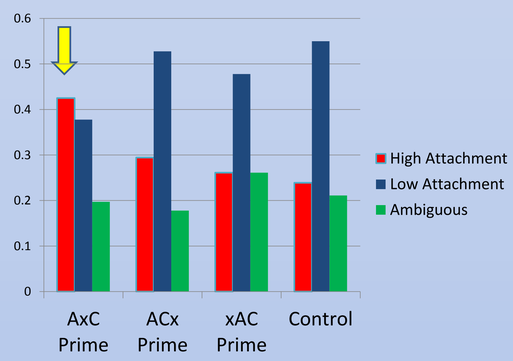


Figure 1. RC Completion Results from Priming and Controls

	HA	LA
YES	105	96
NO	48	40

Figure 2. Item-level Relationship between Correctly saying YES in Priming Test and immediate RC Completion. Fisher's exact test: $p=0.798$

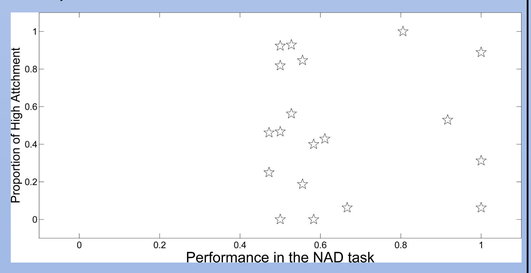


Figure 3. No group-level relationship between Correctness in Priming Test and RC Completion Attachment Biases. Correlation: -0.0538 ($p=0.82$)

4. Discussion

- Abstract relations represented through newly-learned word-level statistical regularities can prime the attachment biases of relative clauses.
- The lack of 'word'-level effects suggest that the representation for RC attachment bias is unlikely to be the same statistical representation at the lexical level that people are trained on.
- This suggests that the underlying representations of attachment biases are best regarded as highly abstract and finely attuned to statistical regularities in the input.

- Future plans: Test this with Spanish. Spanish RCs have a high attachment bias (e.g., Brysbaert & Mitchell, 1996). By priming Spanish speakers with adjacent dependencies, we can see whether their high-attachment bias would be primed to produce low-attachment relative clauses .

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