Syntactic Probability Influences duration: Production of prosodic boundaries in clefted structures

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Overview

- The size, or strength of implementation, of a prosodic boundary depends on the length and complexity of upcoming syntactic structure (Watson and Gibson, 2004)
  - Planning occurs at boundaries, and larger boundaries buy time for planning harder things
- I present experimental evidence that the *probability* of a syntactic structure also influences the implementation of prosodic boundaries
  - The relevant probability is calculated 'locally', within the immediate context
  - Implicit learning occurs, making high-probability structures easier

Background:Syntactic probability and duration

- In a planned production study, Gahl and Garnsey (2004) manipulated the probability of a complement given the subcategorization bias of its verb:

  Clausal complement verb bias:
  Matching: The weary traveler claimed the luggage had been stolen in Rome.
  Mismatching: The weary traveler claimed the luggage at the counter in Prague.

- The duration of the underlined material was longer in bias-mismatching than in bias-matching contexts.

Background: Syntactic probability and duration

- Gahl et al. (2006) find a similar result for early closure vs. late closure sentences with intransitive-bias and transitive-bias verbs

  Transitive verb bias:
  Matching: Soon after the candidate accepted the money, it was found to be illegal.
  Mismatching: Soon after the candidate accepted, the money was found to be illegal.

- Tily et al. (2009) use the Switchboard corpus to find that the probability that a double object will appear as NP PP (rather than as NP NP) influences the duration of the preposition 'to'

Background: Syntactic probability and duration

Conclusion: words are longer in low-probability structures

- *But not all words:* in the first two studies, words **at prosodic boundaries** were lengthened in low-probability contexts, but words elsewhere were not.

Background: Syntactic probability and duration

A wrinkle:

- Suppose that a verb with probabilistic subcategorization biases is actually stored as a set of homophones with categorical subcategorization:
- Then, the difference in predictability of syntactic structure would be represented as simple lexical frequency

Background: Planning and prosodic structure

- Watson and Gibson (2004) propose the 'Left-hand side/ Right-hand side Boundary Hypothesis (LRB)
  The idea: Prosodic boundaries are bigger when preceded or followed by longer syntactic constituents
    - Structure is planned incrementally in 'chunks'
    - Planning of chunks happens at prosodic boundaries
    - If an upcoming chunk requires more planning resources (longer, or more complex), the prosodic boundary will have greater 'weight'
    - The weight of a boundary positively correlates with the size of that boundary

Questions

Question 1: Do speakers use the implementation of prosodic boundaries to 'buy time' for planning low-probability structures?

Question 2: Over what domain is syntactic probability calculated? (long-term or short-term)

Methods: Items

- Planned production with clefts

  Subject-extraction (SE):
  (Did John scam Melvin out of some money?)
  It was Edward who (t) scammed Melvin out of some money.
  Object-extraction (OE):
  (Did Melvin scam John out of some money?)
  It was Edward who Melvin scammed (t) out of some money.

- 21 participants were instructed to read both sentences silently to themselves, then to read the second one aloud.

Methods: Training

- Disentangling lexical frequency from syntactic probability:
  - Object extraction in general is less frequent than subject-extraction in corpora (Roland et al., 2007)
  - But there are other differences:
    - Object extraction has a longer dependency chain
    - Object-extraction structures are more difficult to process (Gibson, 2000; Warren and Gibson, 2002, among many others)

$\rightarrow$ Manipulate the probability of each structure within the experiment

- *This also allows us to compare a structure's 'global' probability to its 'local' probability*

Methods: Training

Table: *Schematic of experiment layout*

	Group 1	Group 2
Pretest:	two of each	
Training:	8 SE	8 OE
Posttest:	two of each	

Methods: Analysis

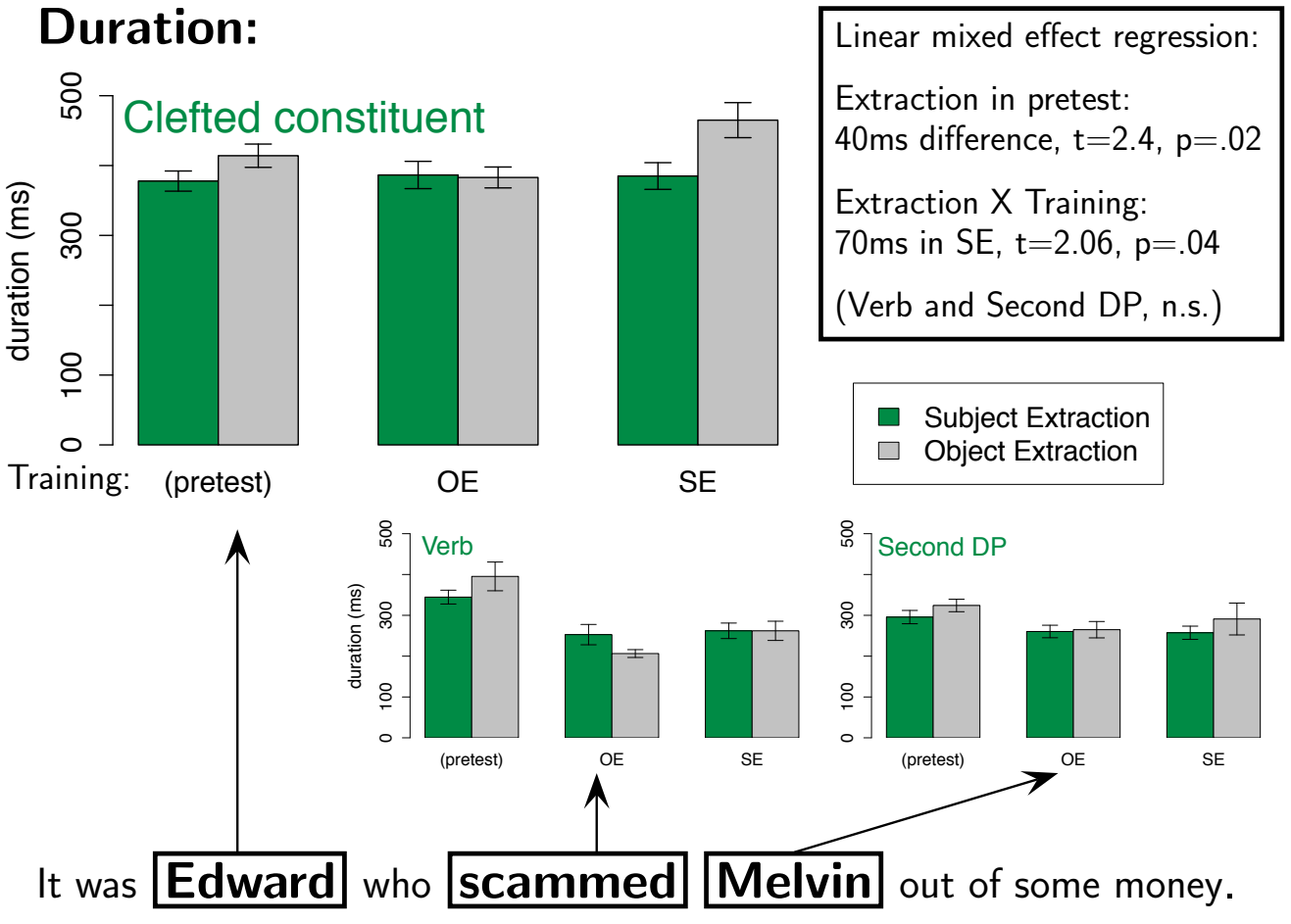
- Utterances recorded using MATLAB
- Four regions of interest were segmented out using the Prosodylab-Aligner (Gorman et al., forthcoming), with minor adjustments

  It was $\underbrace{\text{Edward}}_{1}$ $\underbrace{\text{who}}_{2}$ $\underbrace{\text{scammed}}_{3}$ $\underbrace{\text{Melvin}}_{4}$ out of some money.

Predictions:

- If syntactic probability affects the duration of words, then *some words* should be longer in low-probability structures than in high-probability structures
- If speakers buy time *at prosodic boundaries* for low-prob structures, there should be duration differences on the clefted constituent, and not elsewhere.
- If it's 'global' probability that matters, then training should not affect the outcome
- Whereas if it's 'local' probability that matters, then the two groups of subjects should behave differently in the post-test

Results: Duration



Results: Errors

Mistake type:	Disfluency	SE instead of OE	(out of)
SE training:	7	9	24
OE training:	0	3	20

Discussion:General

- Syntactic probability affects the duration of words at prosodic boundaries
- 'Global' probability governs participants responses at the beginning of the experiment, but they can be trained relatively fast on a new distribution
- More errors are produced on low-probability structures, suggesting a production difficulty

Discussion: Addendum to the LRB

(1) Watson and Gibson, 2004, pg. 732, augmented: LHS/RHS boundary (LRB) weight: The LRB weight at a word boundary between w_1 and w_2 is defined to be the sum of

a. the size of the LHS constituent terminating in w_1, in terms of phonological phrases

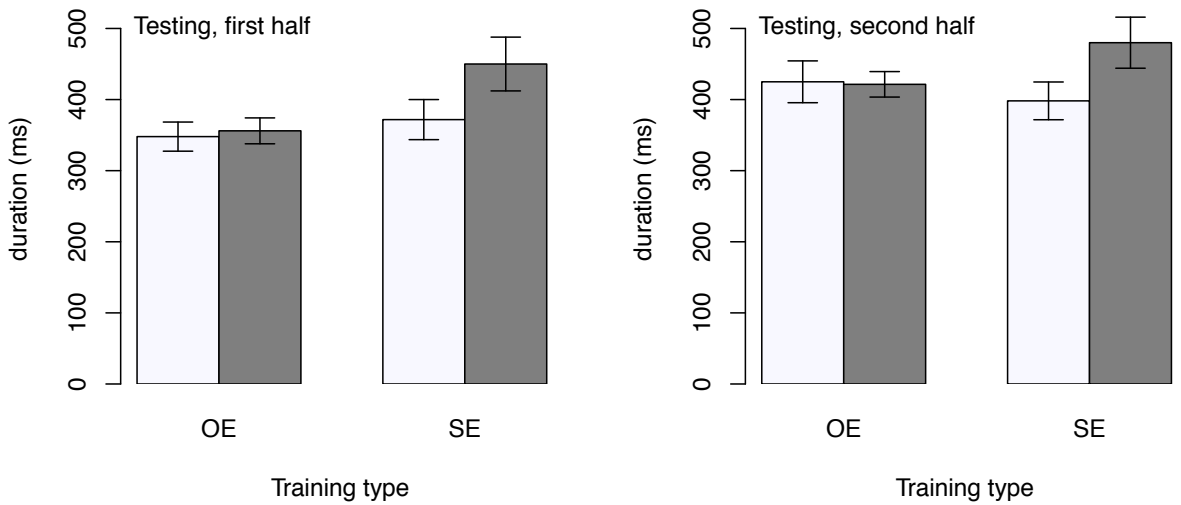
b. the projected size of the RHS constituent in phonological phrases starting at w_2, if this is not an argument of w_1;

c. 1, if w_1 marks the end of a phonological phrase.

d. **1 minus the probability of the upcoming structure**

Discussion: Why are low-probability structures hard to plan?

- Trained structures are primed?
- If so, is it short-term priming, or long-term priming/implicit learning? (Wheeldon and Smith, 2003; Bock and Griffin, 2000; Chang et al., 2000)



Discussion: Why are low-probability structures hard to plan?

- Perhaps speakers gain 'practice' with the trained/high-probability structures
- And that practice leads to shorter planning times
- Which in turn leads to smaller phrase boundaries with less phrase-final lengthening
  - Is the relevant practice production, or would perception also work?
  - Is the practice generalizable? Would training on object-extraction RC's carry over to clefts?
  - How long does the training last?
  - Is training index-able to specific speech contexts? (Warker, forthcoming)

Conclusions

- Speakers 'buy time' at prosodic boundaries for planning upcoming low-probability/untrained structures
- The relevant probability is over the immediate context, not over the speaker's entire past experience with her language taken as a whole.

The future

- A follow-up is in the works, testing:
  - How long does training last? (Each participant will see both training conditions, a week apart)
  - Is training on clefts generalizable to parentheticals?
  - Are there other aspects of the implementation of the prosodic boundary that are modulated with the probability of upcoming structure? (F0, pauses, voice source)

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