The processing of ellipsis

No class+office hours next week, but there will still be a reading!

Extra office hours: April 2 (Thu), 2-3pm; April 10 (Fri), 1:30-3pm. Email for other times!

1 Paper and presentation instructions

1.1 Paper

- 10 pages, not including references
- No need for a title page
- Double spaced
- 12-point font
- 1-inch margins

1.2 Presentation

- 15 minutes per person:
  - 10 minutes presentation,
  - 5 minutes for questions.
- 1-page handout for data (1up, double-sided); **No slides!**
- Your goal:
  - Show the core data your paper is about,
  - Background on why your problem is interesting,
  - What you have to say.

☞ **Submit PDF handout on MyCourses by 14:00 on April 13**

  - Bring computer (or other electronic device) to read handouts on

2 Psycholinguistics

☞ Why study the processing of ellipsis?

- Learn how language is used by speakers and hearers.
  - Study of the psychological and neurobiological factors that enable humans to acquire, use, and understand language.
  - Use humans' behavior when they use language to inform formal linguistic theories.

What kind of measures can be used?

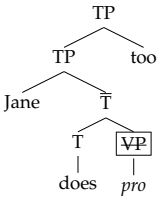
- **Online measures:** measuring participants' behavior as they engage with an experimental task.
  - Readings times
  - Eye-tracking (various measures: fixations, regressions, overall reading time)
  - EEG, MEG (electric, magnetic current at different brain regions; various measures: N400, P600, Mismatch Negativity, (E)LAN; said to correspond to different kinds of linguistic processing)
  - fMRI (blood oxigen levels in the brain, indicating brain activation)

- **Offline measures:** relying on measures that are collected after comprehension of the materials is completed.
  - Acceptability judgments: Natural/unnatural, ratings on a scale, etc.
  - Sentence completion tasks ('madlibs')
  - Picture-matching task

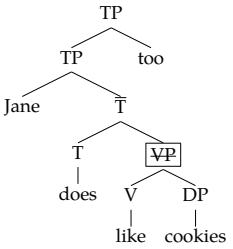
3 Xiang et al. (2014): Priming

The structure question: In elliptical constructions, is there syntactic structure that is unpronounced?

(1) Bill likes cookies, and *proform analysis*



(2) Bill likes cookies, and *full copy in syntax*



The resolution question: Is understood material in ellipsis resolved by reference to the structure and meaning of its antecedent, or just to the meaning?

Assume: The proform analysis requires *semantic licensing* of ellipsis. The full copy analysis requires *syntactic (and semantic) licensing* of ellipsis.[1]

Xiang et al. (2014): Evidence from priming effects for syntax in the ellipsis site.

[1] Life could actually be more complicated than this. Hybrid theories are possible.

3.1 Background: Priming

Syntactic priming: In sentence production, prior recent exposure to certain syntactic structures induces speakers to produce similar structures above a neutral baseline.

Bock (1986), **Procedure**: subjects heard and then repeated a prime sentence with a particular syntactic structure containing a ditransitive verb, either a prepositional dative NP PP structure as in (3a) or a double object NP NP structure as in (3b).

(3) a. A rock star sold [$_{NP}$ some cocaine] [$_{PP}$ to an undercover agent].
b. A rock star sold [$_{NP}$ an undercover agent] [$_{NP}$ some cocaine].

Participants were then asked to describe a picture that depicted an event that had three participants.

Result: the structure that people chose to describe the picture was heavily influenced by the structure they had been exposed to in the prime sentence: more NP PP structures were produced after NP PP primes, and vice versa for NP NP primes.

More generally: This tendency to repeat previously used structures has also been consistently observed in spontaneous speech and in comprehension studies.

3.2 Design

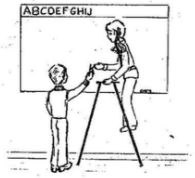
18 target items, each one consisting of a bi-clausal sentence, with its two clauses coordinated with the word 'then' or the words 'and then'.

3 × 2 design, crossing the structure of *clause 1* (prime) and the structure of *clause 2*.

(4) **Item design:**

	Clause 1	
Clause 2	Prepositional Dative (NP PP)	Double Object (NP NP)
Nonelliptical	First Ralph sang a song to Sheila, and then a. Marcus sang one to her.	First Ralph sang Sheila a song, and then d. Marcus sang her one.
Ellipsis	b. Marcus did.	e. Marcus did.
Neutral control	c. Marcus groaned.	f. Marcus groaned.

Each item set was paired with a picture that could plausibly be described with a ditransitive (i.e., prepositional dative or double-object) verb.



Fillers: bi-clausal sentences, half with transitive verbs in their active or passive forms, half with intransitive verbs. Each filler item was paired with a picture that could plausibly be described by a transitive verb or an intransitive verb, depending on the type of prime.

Target items divided into 6 lists, with Latin Square design = 18 target trials per participant. In addition, 38 fillers = 56 trials in total. Items randomized for each participant.

3.3 Procedure

84 English speakers, 18–35yo. Payment: $10 per hour or course credit.

Participants sat isolated in a quiet room with a keyboard and a headset containing headphones.

(5) **The sequence of events in a single trial:**
a. Sentence presented on screen for 5000ms (5 seconds)
b. Blank screen appeared
c. The same sentence is spoken to participants through the headphones
d. An instruction appears on the screen: "Please repeat"
e. Participants press the spacebar when done
f. A picture is presented on the screen
g. Participants orally describe the event depicted in the picture using a single sentence
h. Participants press the spacebar to begin the next trial

Before experiment begins: 10 **practice trials** while a researcher watched. Practice trials had the same procedure as the experimental trials and filler-like structures (all different from the actual fillers).

Data was **coded for the structure of the sentence** produced by participants.

67% of the data (975 tokens in total) was coded as having a NP NP structure (e.g., "A girl is passing a boy a ball") or an NP PP structure (e.g., "A girl passed something to someone who was reaching out to catch it").

The rest was coded as having an unrelated structure (e.g., "A boy and a girl are playing catch" or "A girl is throwing a ball for a boy to catch").

3.4 Results

A small set of ditransitive verbs were used to describe the picture stimuli:

Verb	Frequency	Verb	Frequency
hand	385	pass	18
give	256	sell	4
read	126	display	2
offer	65	deliver	1
show	53	demonstrate	1
serve	22	hold	1
bring	20	lend	1
present	19	tell	1

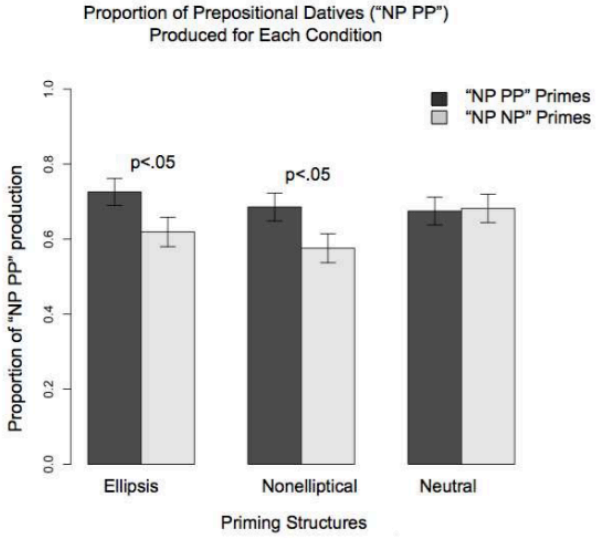
Frequency of each of the two target structures (NP NP and NP PP) produced under each condition:

	NP PP Prime			NP NP Prime		
	Non-elliptical	Ellipsis	Neutral	Non-elliptical	Ellipsis	Neutral
NP PP	108	121	110	98	98	105
NP NP	51	43	56	72	63	50

There is an overall **bias for NP PP** structures across the board.

There is also a clear **interaction** between the *structure of the priming sentence* and the *produced sentence*: More matching productions in non-elliptical and elliptical conditions compared to neutral control.

Taking NP NP productions as a baseline:
If priming structure is non-elliptical or elliptical structure with NP PP sentence ⇒ increase in NP PP productions (10% and 12% respectively, relative to such productions after the NP NP primes);
No such priming effect when clause 2 was the neutral control, a simple intransitive.



3.5 Conclusions

Summary of results: priming effect when clause 1 and clause 2 both contain NP PP structure, or when the second clause contains ellipsis. No priming effect when clause 2 is intransitive.

- ☞ Just one instance of NP PP structure is insufficient to cause a priming effect.
- ☞ Ellipsis sentence patterns with non-elliptical sentence.
  - **Explained under a syntactic approach to ellipsis licensing**.
  - Unexplained by semantic approach to ellipsis licensing, because NP NP structure and NP PP structure are semantically identical.

4 Aparicio et al. (2014): Eye-tracking

Recall **the resolution question**: Is understood material in ellipsis resolved by reference to the structure and meaning of its antecedent, or just to the meaning?

I.e., should we have a *syntactic* or *semantic* identity condition?

Voice mismatches under ellipsis have constituted a major domain for investigation of this question. The ungrammaticality of certain voice mismatches suggest that the identity condition is syntactic:

(6) * This problem was looked into by John, and Bill did too.
(7) * This information was released but Gorbachov didn't.

However, certain mismatches are acceptable:

(8) This problem was to have been looked into, but nobody did.

A noted **cline** in acceptability for VPE voice mismatches suggests that the facts are more nuanced (Frazier and Clifton, 2001; Arregui et al., 2006; Kim et al., 2011).[2]

(9) a. None of the astronomers saw the comet, but John did.
b. ? Seeing the comet was nearly impossible, but John did.
c. ?? The comet was nearly impossible to see, but John did.
d. ??? The comet was nearly unseeable, but John did. (Arregui et al., 2006)

Another possible area of investigation: ϕ**-feature mismatches in ellipsis**.

It has been argued that inflectional ϕ-features are not relevant in ellipsis computation:

(10) **Brazilian Portuguese** (Nunes & Zocca 2009; Masullo & Depiante 2004, for Spanish)

O João é alto e a Maria também é ~~alta~~.
the João is tall.masc.sg and the Maria also is tall-fem.sg

'João is tall and Maria is too.'

Inflectional ϕ-features are not typically analyzed as contributing to the semantic representation.

The availability of inflectional ϕ-feature mismatches can be accounted for if we assume a **semantic identity condition** for ellipsis.

An alternative syntactic approach: predicate adjectives enter the derivation unspecified for ϕ-features (Nunes & Zocca 2009):

(11) a. [[O João] é [$_{\text{AgrP}}$ Agr$_{\text{masc.sg}}$ [$_{\text{AP}}$ alt-]]]
b. [[a Maria] também é [$_{\text{AgrP}}$ Agr$_{\text{fem.sg}}$ [$_{\text{AP}}$ alt-]]]

Aparicio et al. (2014): (i) Contra previous claims, ellipsis is sensitive to inflectional ϕ-feature mismatches. (ii) Ellipsis resolution is sensitive to the syntactic structure of the antecedent. A purely semantic resolution process for ellipsis cannot account for this data. (iii) There exists a different time-course effect for deep anaphora and ellipsis resolution suggestive of syntactic identity.

[2] Two kinds of proposals for why we get this cline: (i) Discourse coherence plays a role in the resolution of these mismatches (Kehler, 2001; Kertz, 2013); (ii) The cline results from extra processing cost (Arregui et al., 2006; Kim et al., 2011).

4.1 Design

Eye-tracking experiment, conducted in Spanish.

Three structures tested:

1. Ellipsis
2. Non-elliptical ('Full')
3. Predicate pronominal (Spanish *Lo*, a 'deep anaphor', per Hankamer and Sag 1976)

(12) [Hankamer attempts to stuff a 9-inch ball through a 6-inch hoop]
Sag: It's not clear that you'll be able to do it. Deep anaphora)
Sag: #It's not clear that you'll be able to. Ellipsis/Surface anaphora

Spanish *lo* does not require a linguistic antecedent. It can be pragmatically controlled:

(13) *Context*: The tallest players on the basketball team are getting picked to play in the national team. Juan does not get picked and he yells angrily at the coach:
a. Por qué no he sido seleccionado? **Yo lo soy también**!
for what not have been selected? I it am too!
'Why haven't I been selected? I am ~~tall~~ too!'
b. Por qué no he sido seleccionado? **#Yo también**!
for what not have been selected? I too!
'Why haven't I been selected? I am ~~tall~~ too!'

Two features examined: *Gender* (masculine vs. feminine) and *Number* (singular vs. plural).

2 × 2 design, crossing *Match* (feature match versus mismatch with the antecedent) and *Feature on the Subject of the Second Clause* (SSC).

(14) a. **El** ciclista es alt**o** y **el** futbolista también.
the.**m** cyclist is tall.**m** and the.**m** football-player too
b. La ciclista es alta y la futbolista también.
the.f cyclist is tall.f and the.f football-player too
c. La ciclista es alta y **el** futbolista también.
the.f cyclist is tall.f and the.**m** football-player too
d. **El** ciclista es alt**o** y la futbolista también.
the.**m** cyclist is tall.**m** and the.f football-player too
'The cyclist is tall, and the football player is too.' ellipsis

(15) a. **El** ciclista es alt**o** y **el** futbolista es alt**o** también.
the.**m** cyclist is tall.**m** and the.**m** football-player is tall.**m** too
'The cyclist is tall, and the football player is tall too.' full

(16) a. **El** ciclista es alt**o** y **el** futbolista **lo** es también.
the.**m** cyclist is tall.**m** and the.**m** football-player **lo** is too
'The cyclist is tall, and the football player is (tall) too.' *lo*

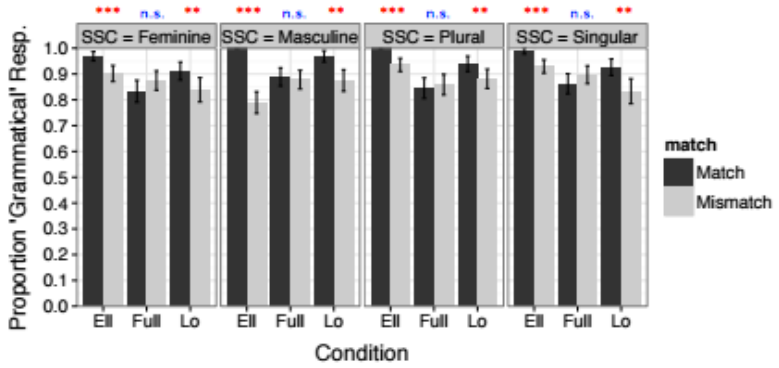
(Same design for number; all nouns are masculine, singular vs. plural)[3]

49 Spanish speaking participants; 80 target trials + 50 ungrammatical fillers.

[3]Each full trial in (15)–(16) contains 4 items, along the lines of (14); same for items with number.

4.2 Results: offline measures

Grammaticality judgments for Gender and Plural items:[4]



- All example sentences judged to be **highly acceptable** (> 75% 'grammatical').
- Significant **mismatch penalty** in *Ellipsis* and *Lo* conditions; not in *Full* conditions.
- Same effects found for Gender and Number items.

4.3 Results: online measures

4.3.1 Eye-tracking measures

Eye movements are typically divided into **fixations** and **saccades** – when the eye gaze pauses in a certain position, and when it moves to another position, respectively.

The sentence is split up into *regions*.

(17) **Critical regions:**
a. El ciclista | es alto | y | el futbolista | **también**.
the.m cyclist | is tall.m | and | the.m football-player | **too**
b. El ciclista | es alto | y | el futbolista | **es alto** | **también**.
the.m cyclist | is tall.m | and | the.m football-player | **is tall.m** | **too**
c. El ciclista | es alto | y | el futbolista | **lo es** | **también**.
the.m cyclist | is tall.m | and | the.m football-player | **it is** | **too**

Things linguists are usually interested in include: (i) First-Fixation Duration; (ii) First Pass Reading time (a.k.a. "First Run Dwell Time"); (iii) Total Reading Time (a.k.a. "Total Dwell Time"); (iv) Regression Path Duration; (v) Regressions.

The first four measures are linear variables, typically counted in milliseconds. The fifth measure, regression, is a binary value whether the first fixation away from the target word was on to the next word in the sentence (or beyond) or back to an earlier part of the sentence (a "regression").[5]

[4]Recall: SSC = Subject of the Second Clause.

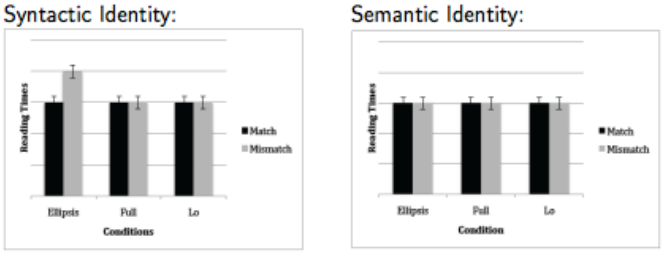
[5]See `https://wiki.brown.edu/confluence/display/kertzlab/Eye-Tracking+While+Reading` for an easy to follow explanation of these measures.

Measures relevant for this experiment:

- **Regression Path** (RP): Total durations of the fixations in all the regions up to and including the region of interest, before the region is exited to the right (early processing measure).
- **Total Time** (TT): Total duration for all fixations in a given region (late processing measure).

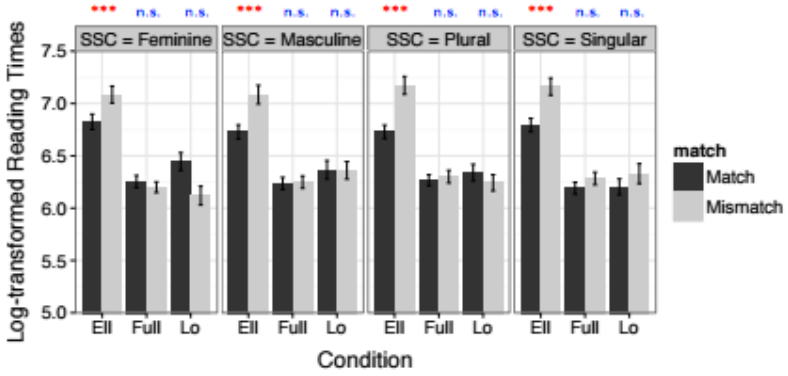
4.4 Hypothetical results

Grammaticality judgments were collected for target sentences. Predictions:



4.5 Actual results

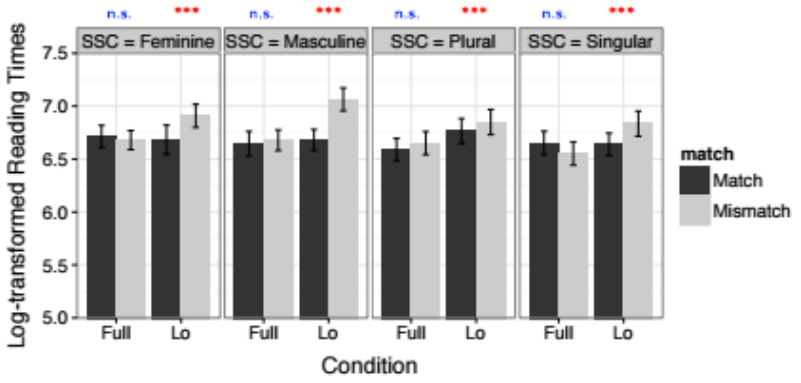
Results for the Critical Region: Regression Path Fixation Times[6]



- Significant **mismatch penalty for RP** for *Elliptical* sentences; no penalty for *Full* or *Lo* structures.
- Same effect found for Gender and Number items
- Same effects found for TT (not shown here).

[6]Log-transformed reading times help us compare across speakers, conditions and experiments. They remove a lot of noise contributed by the fact that different people might have different reading speeds, length of words, etc.

Post-Critical Region (CR+1): Regression Path Fixation Times



- Significant **mismatch penalty for RP** in *Lo* sentences, but not *Full* sentences.[7]
- Same effect found for Gender and Number.
- No signifiant results for TT.

☞ **Summary:**
Contra previous claims, **ellipsis is sensitive to inflectional ϕ-feature mismatches**, as evidenced by decreased acceptability and increased processing difficulty for mismatches between the ellipsis site and the antecedent.

4.6 Discussion

Time-course difference in mismatch effect between *Ellipsis* and *Lo* sentences ⇒ evidence for differences in the nature of this effect

- *Ellipsis* mismatches processed earlier in time (critical region)
- *Lo* sentences processed later in time (post-critical region)

Surface Anaphora: early effects of mismatch in Ellipsis provide evidence for calculation of syntactic identity

Deep Anaphora: later effects of mismatch on *Lo* suggest that mismatch is not relevant at the syntactic level; rather, discourse parallelism between antecedent and anaphor factors into increased processing times.[8]

[7]Recall: there is no CR+1 region in ellipsis sentences.

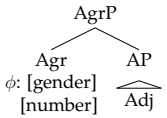
[8]Sensitivity to feature mismatch for deep anaphora has been found in previous literature (Murphy 1985; Tanenhaus et al. 1990; Mauner et al. 1995; Duffield 2009; Duffield & Matsuo 2009; Roberts, et al. 2013).
Time-course differences between deep and surface anaphora have also been found (Roberts, et al. 2013; Hestvik, et al. 2006).

Aparicio et al. (2014): Structure building in sentence parsing occurs incrementally, using a parsing heuristic to allow for maximal efficiency.

(18) **MaxElide**
Ellipsis targets configurationally higher nodes over lower nodes (Merchant, 2008; Kim et al., 2011)

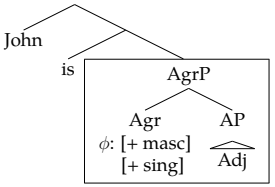
Lets assume the structure below for the predicate (Nunes and Zocca, 2009):

(19)

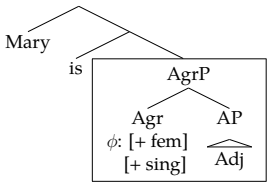


The parser proceeds **iteratively** looking for the right antecedent:

(20)



(21)



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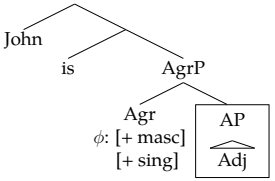
This choice leads to a mismatch, so a smaller option is attempted:

(22)



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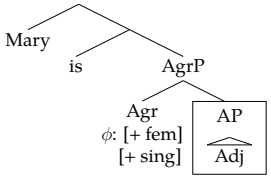

✓

We converge on a structure that correctly licenses the ellipsis. The parser needs to perform extra steps in order to retrieve the correct antecedent in mismatch cases, so we might expect an effect on overall acceptability as well as on processing times.

References

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