

How grammar and predictability affect pronoun production and interpretation: evidence from interactive tasks

Laia Mayol

Universitat Pompeu Fabra

Workshop ‘Referring expression choice in grounded contexts:
Linguistic, cognitive, and computational aspects’

ESSLLI 2026

Joint work with



Mora Maldonado
Universitat Pompeu Fabra



Xixian Liao
Barcelona Supercomputing
Center

Research question

- (1) Gemma and Louise
The amazing organizers of the CORE workshop
They

How do speakers decide which referential expression to use? How do listeners interpret pronominal expressions?

Research question

Which factors affect pronoun use? Do they affect production & interpretation equally?

- ▶ Structural / grammatical properties of the antecedent: i.e. subjects make good pronominal antecedents.
- ▶ Predictability: how likely it is that we are talking about the referent.

Previous work

- ▶ Previous work has mostly used Discourse Completion Tasks (Bader et al. 2019; Patterson et al. 2022; Rohde 2019; Rohde and Kehler 2014; Zhan et al. 2020)
- (2)
- a. Amanda amazed Brittany. _____ [Bare prompt]
 - b. Amanda amazed Brittany. She _____ [Pronoun prompt]

Previous studies

Previous studies mostly manipulate predictability through non-structural linguistic items (verb type, discourse relations), i.e. implicit causality verbs:

- (3) a. *Amanda* amazed Brittany.
 b. Amanda thanked *Brittany*.
- ▶ *Amanda* is more predictable in (a) than in (b).
 - ▶ Does this imply that it is pronominalized more often in (a) than in (b)?

Previous studies

Mixed results on whether predictability affects pronoun production:

- ✗ Fukumura et al. 2010; Holler et al. 2016; Kehler 2019;
Kravtchenko 2022; Lam et al. 2022; Liao et al. 2024; Mayol 2018;
Patterson et al. 2022; Rohde and Kehler 2014
- ✓ Arnold 2001; Hwang 2023; Konuk et al. 2021; Medina Fetterman
et al. 2022; Weatherford et al. 2021; Zerkle et al. 2019
- ▶ Small positive effect in Liao's et al. 2025 meta-analysis

Models

Two models aim to capture the relationship between predictability and pronoun production.

1. Bayesian Model
2. Expectancy Model

Bayesian Model (Kehler, Kertz, et al. 2008; Kehler and Rohde 2013)

- Interpretation and production are not always symmetric.

(4) Stevenson et al. 1994

- John passed the comic to Bill. He _____
- John passed the comic to Bill. _____

- Pronoun interpretation can be affected by how predictable the referent is.

Bayesian Model (Kehler, Kertz, et al. 2008; Kehler and Rohde 2013)

- ▶ Weak Bayes: Interpretation and production are related through Bayes rule.

$$P(\textit{referent} \mid \textit{pronoun}) \approx P(\textit{pronoun} \mid \textit{referent}) \times P(\textit{referent}) \quad (1)$$

- ▶ Strong Bayes: non-structural factors influence predictability and, thus, interpretation; in contrast production is only affected by grammatical/structural factors.

- (5)
- a. Amanda amazed Brittany.
 - b. Amanda thanked Brittany.

Expectancy Model (Arnold 1998, 2010)

- ▶ Referent predictability closely tied to accessibility/salience.
- ▶ Pronouns are used for referents that are highly accessible and, thus, predictable for the listeners.
- ▶ Predictability can come from multiple sources: both structural and non-structural factors.
- ▶ Predictability affects both interpretation and production.

- (6)
- a. Amanda amazed Brittany.
 - b. Amanda thanked Brittany.

General goal

- ▶ Study the role of **predictability** in the production and interpretation of referring expressions in an **interactive set-up**.
- ▶ A speaker and a listener were paired online and asked to communicate.
- ▶ Task in Spanish: full DP vs null pronoun.
- ▶ Why would an interactive set-up have an impact?
 - ▶ **Accuracy** and **cost** matter

General goal

Today

- ▶ Norming study
- ▶ Interactive studies
 - ▶ Forced choice
 - ▶ Free production

Norming study

- ▶ **Goal:** Assess the predictability of possible referents in a two-event story. Select events where the predictability is more extreme.

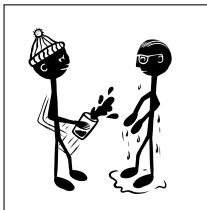
Norming study

- ▶ **Goal:** Assess the predictability of possible referents in a two-event story. Select events where the predictability is more extreme.
- ▶ 50 Spanish-speaking participants were presented with a first vignette where one **agent** is doing something to **patient**.

Main Transitive Event

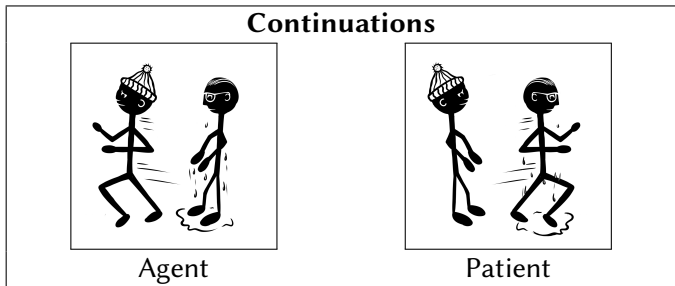
El hombre de gorro moja al de gafas.

The man with the hat throws water at the man with glasses.



Norming study

- ▶ **Goal:** Assess the predictability of possible referents in a two-event story. Select events where the predictability is more extreme.
- ▶ 50 Spanish-speaking participants were presented with a first vignette where one **agent** is doing something to **patient**.
- ▶ Participants were then asked to select most likely continuation among two options.

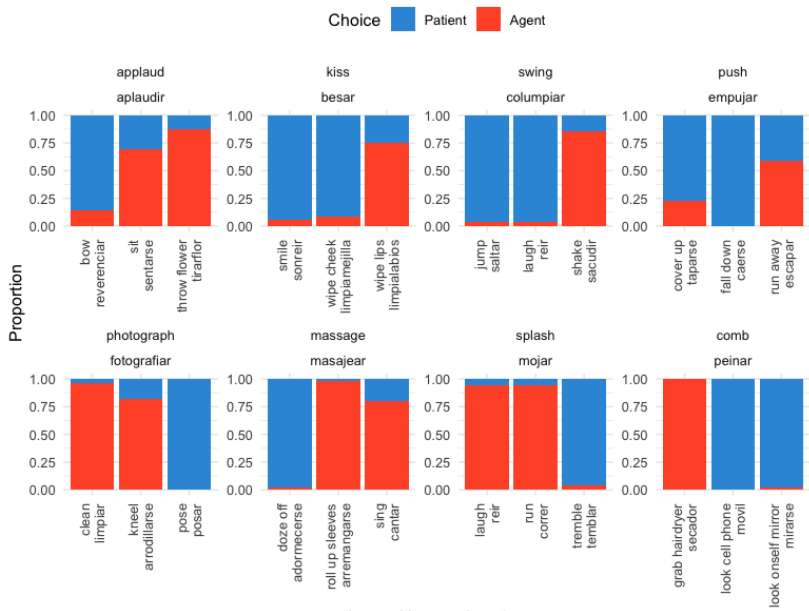


Norming study

- ▶ **Goal:** Assess the predictability of possible referents in a two-event story. Select events where the predictability is more extreme.
- ▶ 50 Spanish-speaking participants were presented with a first vignette where one **agent** is doing something to **patient**.
- ▶ Participants were then asked to select most likely continuation among two options.
- ▶ There were 8 transitive events, each tested with three different continuation events.

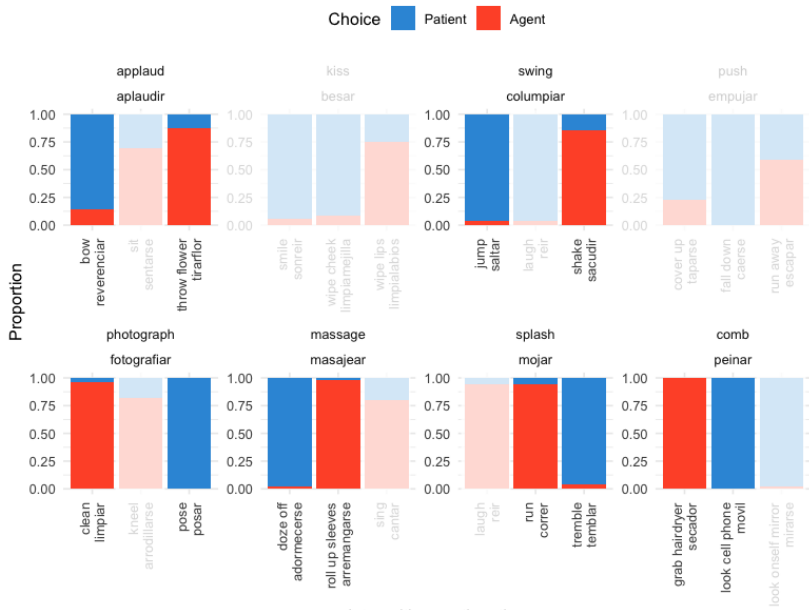
Norming study

Results (N=50)



Norming study: Selected events

Results (N=50)



Forced choice study

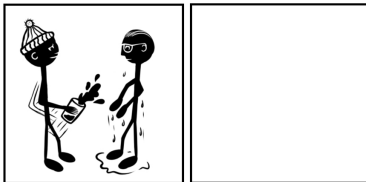
à la Kanwal et al. 2017

- ▶ Participants play either the role of the speaker or of the listener.
d
- ▶ Speakers were told they would need to communicate a scene to a partner as **quickly** and **accurately** as possible.

Forced choice study: Procedure

The speaker's perspective

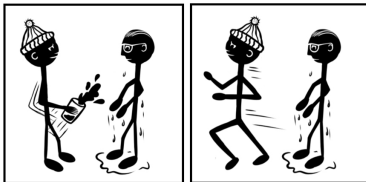
El hombre de gorro moja al de gafas.



Forced choice study: Procedure

The speaker's perspective

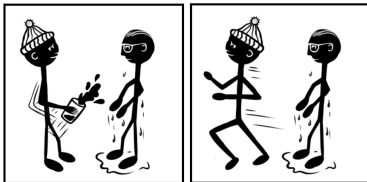
El hombre de gorro moja al de gafas.



Forced choice study: Procedure

The speaker's perspective

El hombre de gorro moja al de gafas.



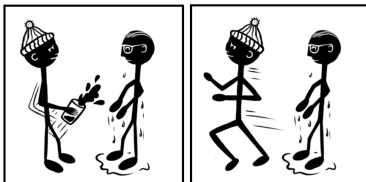
El hombre del gorro corre.

Corre.

Forced choice study: Procedure

The speaker's perspective

El hombre de gorro moja al de gafas.



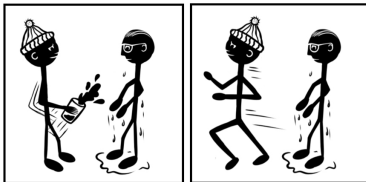
El hombre del gorro corre.

Corre. 

Forced choice study: Procedure

The speaker's perspective

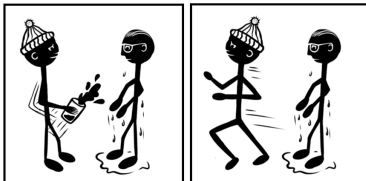
El hombre de gorro moja al de gafas. C



Forced choice study: Procedure

The speaker's perspective

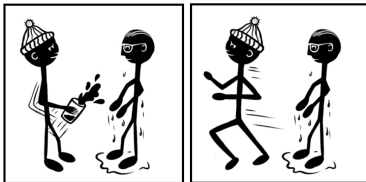
El hombre de gorro moja al de gafas. Co



Forced choice study: Procedure

The speaker's perspective

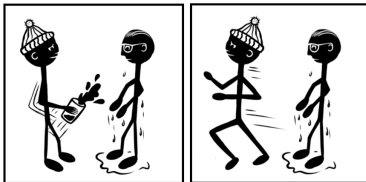
El hombre de gorro moja al de gafas. Cor



Forced choice study: Procedure

The speaker's perspective

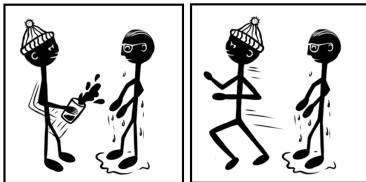
El hombre de gorro moja al de gafas. Corr



Forced choice study: Procedure

The speaker's perspective

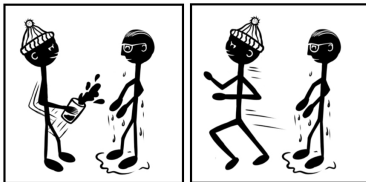
El hombre de gorro moja al de gafas. Corre



Forced choice study: Procedure

The speaker's perspective

El hombre de gorro moja al de gafas. Corre.



Forced choice study: Procedure

The speaker's perspective

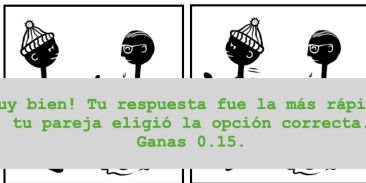
El hombre de gorro moja al de gafas. Corre.



Forced choice study: Procedure

The speaker's perspective

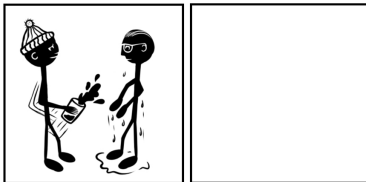
El hombre de gorro moja al de gafas. Corre.



Forced choice study: Procedure

The listener's perspective

El hombre de gorro moja al de gafas.



Forced choice study: Procedure

The listener's perspective

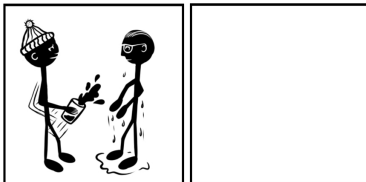
El hombre de gorro moja al de gafas.



Forced choice study: Procedure

The listener's perspective

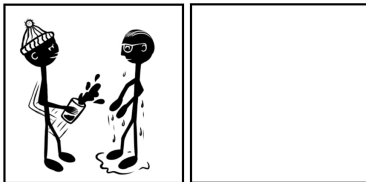
El hombre de gorro moja al de gafas. C



Forced choice study: Procedure

The listener's perspective

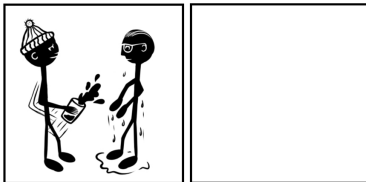
El hombre de gorro moja al de gafas. Co



Forced choice study: Procedure

The listener's perspective

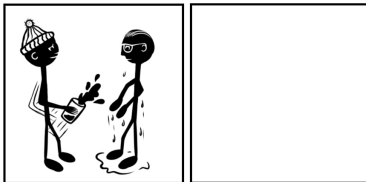
El hombre de gorro moja al de gafas. Cor



Forced choice study: Procedure

The listener's perspective

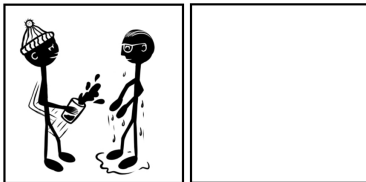
El hombre de gorro moja al de gafas. Corr



Forced choice study: Procedure

The listener's perspective

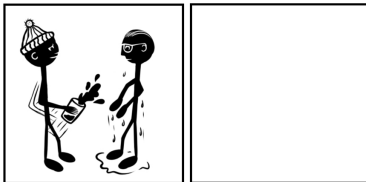
El hombre de gorro moja al de gafas. Corre



Forced choice study: Procedure

The listener's perspective

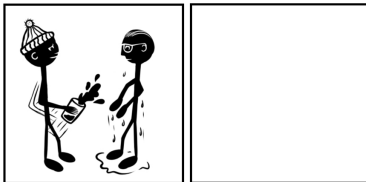
El hombre de gorro moja al de gafas. Corre.



Forced choice study: Procedure

The listener's perspective

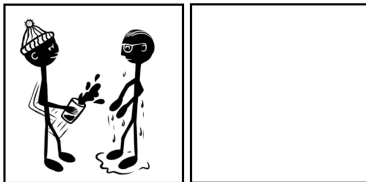
El hombre de gorro moja al de gafas. Corre.



Forced choice study: Procedure

The listener's perspective

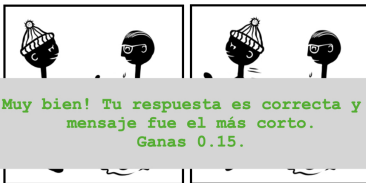
El hombre de gorro moja al de gafas. Corre.



Forced choice study: Procedure

The listener's perspective

El hombre de gorro moja al de gafas. Corre.

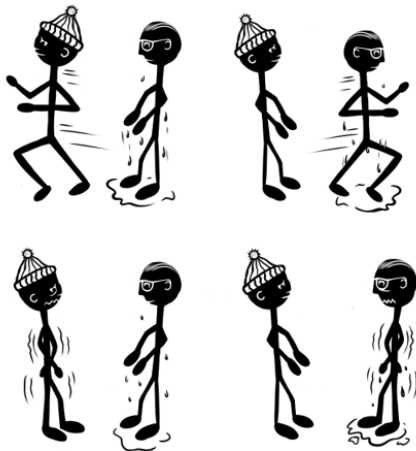


¡Muy bien! Tu respuesta es correcta y el
mensaje fue el más corto.
Ganas 0.15.



Forced choice study: materials

We manipulate **Actual Referent** and **Predicted Referent**, based on the norming study

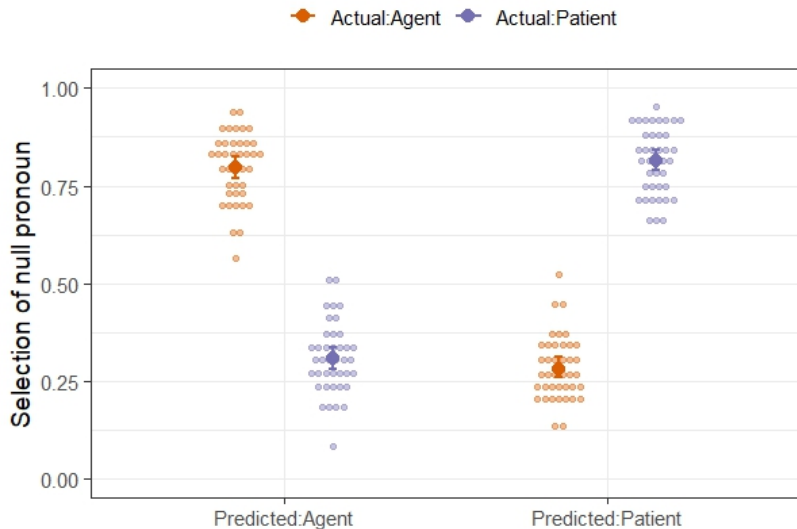


Forced choice study: Participants

- ▶ 140 participants, 70 pairs, native speakers of Spanish from Spain
- ▶ Bonus of 0.01 £ for each correct response, bonus of 0.10 £ for correct and fast responses. Penalization of 0.01 for incorrect answers.

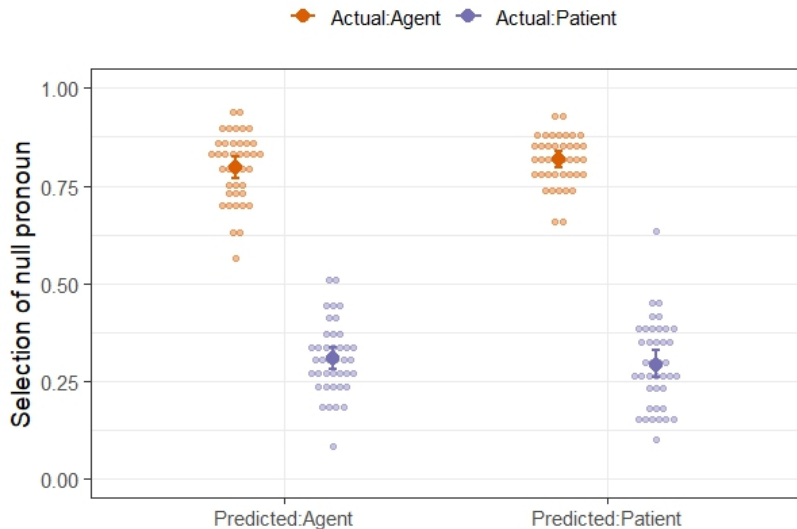
Forced choice study: Simulation

If predictability affects production

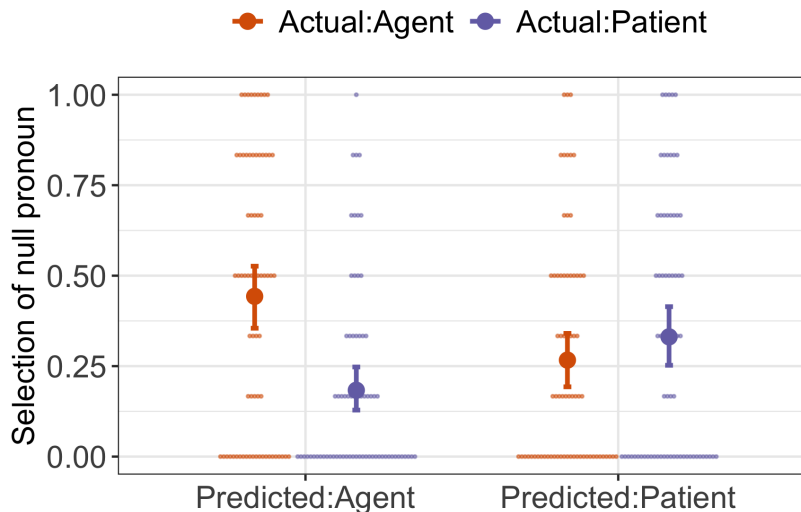


Forced choice study: Simulation

If predictability doesn't affect production

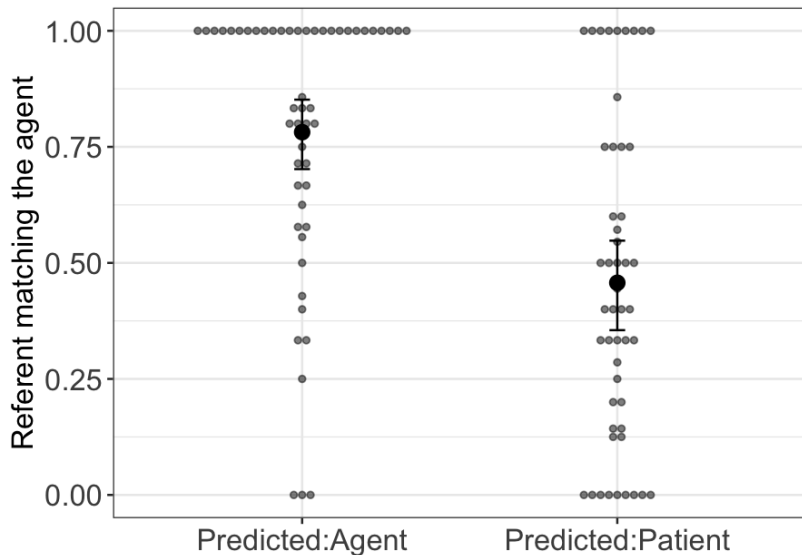


Forced choice study: Production results



Actual x Predicted interaction ($\beta = 0.54$, $z = 9.3$, $p < .001$)

Forced choice study: Interpretation of nulls



Predictability ($\beta = 1.00$, $z = 4.8$, $p < .001$)

Forced choice study: Discussion

- ▶ Effect of predictability on pronoun production.
- ▶ Models of pronominal use need to include pragmatic speakers (who consider the listener).
- ▶ Production of full DPs exceeds what would be efficient (70%)
 - ▶ Is the pressure for accuracy too high?
- ▶ Cost and production were not realistic.

Free production study

¿De quién es el turno?

Director (Tú)

Bonus acumulado: 0.00€

Rtas. correctas: 0/0

Rtas. rápidas y correctas: 0/0



El hombre del gorro moja al de las gafas.



Verbos posibles: temblar, tener frío, tiritar

Escribe una oración para describir la continuación:

Escribe tu oración aquí...

¡Listo!

Free production study

Same procedure as above, except:

- ▶ A predicate was given to describe the continuation (i.e. 'run away').
- ▶ The speaker was asked to type a sentence containing that predicate.
- ▶ "Your goal is to help your partner identify the correct vignette with a sentence that is clear and concise."

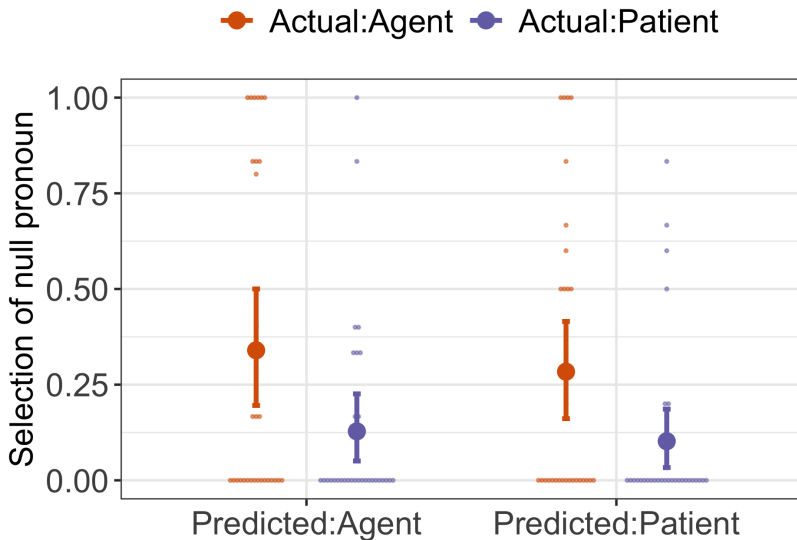
Free production study

- ▶ 66 participants (33 pairs)
- ▶ Exclusion of 114 data points (14%): telegraphic language, subordinate sentences, use of other predicates

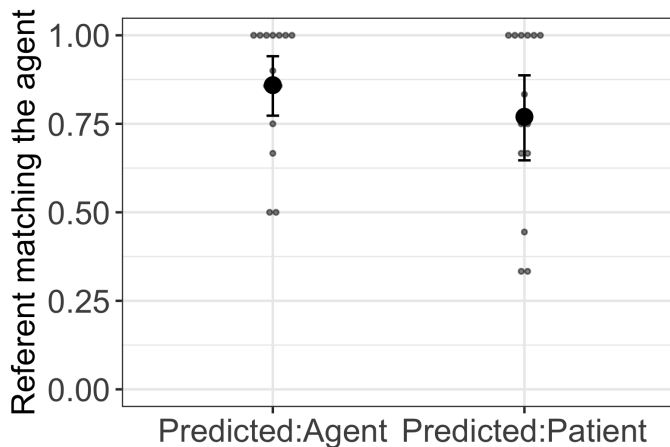
Free production study: Production results

Category	%	Example
Modified DP	50.8	<i>la mujer de gafas</i> 'the woman with glasses'
Elliptical DP	20.8	<i>la de gafas</i> 'the one with glasses'
Null pronoun	20.5	Ø
Bare DP	3.8	<i>la mujer</i> 'the woman'
Relational DP	2.2	<i>el otro, la última, el primero</i> 'the other one', 'the last one', 'the first one'
Overt pronoun	1.3	<i>él, ella</i> 'he', 'she'
Demonstrative pronoun	0.4	<i>este</i> 'this one'

Free production study: Production results



Free production study: Interpretation of nulls



Comparison between the two studies

	Forced choice	Free production
% of nulls	30	20
% of speakers not using nulls	21	52
Accuracy of nulls	61	83
Connectors	no	yes
Event description	fixed	manipulable

Free production study: Production results

Connectors

DPs	12%
Nulls	83%

- ▶ Mostly temporal connectors (90.2%).
- ▶ *y* ('and'), *y luego* ('and then'), *después* ('after') → 77%
- ▶ In nulls, connectors indicate topic continuity: 82% with Agent antecedents vs 36% with Patient antecedents

Actual: agent; Predicted: patient

- (7) La mujer de los rulos masajea a la de las pecas. Y luego se duerme.
'The woman with the curlers massages the one with freckles.
And then $\emptyset$ falls asleep.

Free production study: some examples

Actual: patient; Predicted: agent

- ▶ La mujer de la coleta peina a la de las gafas. Coge el secador para secarse.
'The woman with the ponytail combs the woman with the glasses. Ø picks up the hairdryer to dry her own hair.'
- ▶ El hombre del gorro moja al de las gafas. Y sale corriendo mojado.
'The man wearing the beanie splashes the man with the glasses. And Ø runs away soaking wet.'
- ▶ El hombre de la gorra fotografía al de las gafas. Y luego le limpia la cámara.
'The man wearing the cap takes a picture of the man with the glasses. And then Ø cleans the camera for him.'

Conclusion

Predictability affected not only pronoun interpretation but also production in an interactive setting with forced choice.

We couldn't replicate this finding in a free production experiment:
Too little data? Due to the methodological change?

Accuracy was higher in the free production experiment and interpretation not sensitive to predictability probably because speakers were able to make their productions not-ambiguous.

Predictability affects both pronoun production and interpretation: evidence from an interactive task

Thank you!

Laia Mayol
laia.mayol@upf.edu
Universitat Pompeu Fabra

This research is part of the project EXPEDIS (PID2021-122779NB-I00) funded by MICIU/AEI/10.13039/501100011033 and by “ERDF A way of making Europe”.

Interpretation results

Antecedent	Predictability	Accuracy (total)
Agent	Agent	79.6 (186)
Agent	Patient	53.6 (112)
Patient	Agent	23.4 (77)
Patient	Patient	64.7 (139)

Table: Forced choice

Antecedent	Predictability	Accuracy (total)
Agent	Agent	96.4 (56)
Agent	Patient	90.9 (44)
Patient	Agent	42.9 (21)
Patient	Patient	72.7 (18)

Table: Free production