Linguistics

Language Acquisition Lab

Two kinds of adjective-infinitive constructions in acquisition

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Introduction

Predicates and infinitival complements

The natural class of tough-predicates

- Certain subjective, event-modifying predicates, like *tough*, *easy*, *impossible*, *nice*... take infinitival clauses as complement [1]–[3].
- Those predicates are called **tough**-predicates and are involved in **tough**-constructions (**TC**), which are typologically unusual [4].
- **TCs** are compatible with missing-**object** (cf. (1a)) or missing-adjunct (cf. (1b)) infinitives, but not with missing-**subject** infinitives (cf. (1c)).
- We call the missing element in the infinitive the **gap** (__).

(1) a. Suzi is **tough** for Joseph to talk to __. **object-TC**

b. This car is **tough** to drive on this road with __. adjunct-**TC**

c. * Joseph is **tough** __ to talk to Suzi. ***subject-TC**

What is going on with adults and tough-constructions?

TCs are tough to account for...

- Let alone the gap-specificity of **TCs**, **those constructions have been a longstanding puzzle in theoretical syntax**:
  - They exhibit properties of both A- and $\bar{A}$-movement [5], [6], suggesting they are Improper Movement structures [7], normally banned from the grammar (cf. Appendix slides 24 and 25).
  - They allow for an "expletive" variant, whereby the infinitival clause is gapless, and the subject is a vacuous *it*, which poses problem to the theory of thematic roles (cf. Appendix slide 26).

... and tough to acquire!

- The syntactic complexity of **TCs** may be the reason why **they are notoriously late acquired (around 6 y.o.)** [8]–[12] and mistaken for **subject**-gap structures.
- To better understand the puzzle posed by **TCs**, we want to compare their acquisition against that of another similar infinitival construction which is less problematic from a theoretical standpoint.

How about other well-studied infinitival constructions?

The gap-specificity of TCs

- Other well-studied infinitival constructions have "gaps": raising constructions (cf. (2)), control constructions (cf. (3))...
- The acquisition of **TCs** as opposed to raising constructions has been recently investigated [13].
- But, contrary to **TCs**, raising and control constructions are only compatible with **subject**-gaps.
- **This would be an unfair comparison, as the study of subject- and object-relative clauses has shown that subject-gap dependencies might be systematically easier to process than object-gap dependencies [14], [15].**

(2) The student seems __ to have passed the exam. Raising

(3) The student promised __ to be on time. Control

A better candidate for a comparison with TCs

Gapped-degree phrase are (at least) superficially similar to TCs

- Gradable adjectives, like *fast*, *big*, *hot*... also allow infinitival clauses when degree-modified *via too* or *enough*.
- The corresponding construction is called a gapped-degree phrase (**GDP**, cf. (4a)).
- This construction, despite being been less studied than raising or control (though see [16], [17]), seems more similar to **TCs**, because it allows for **object**-gaps.
- Yet, unlike **TCs**, **GDPs** are compatible with **subject**-gaps (cf. (4b)).
- **In our study, we compare the acquisition of subject- and object- TCs and GDPs using an Elicited Imitation task.**

(4) a. Lisa is **too** fast for Joseph to follow __. **object-GDP**

b. Joseph is **too** slow __ to follow Lisa. **subject-GDP**

Study

How specific is the difficulty generated by TCs?

	TC	GDP
subject	*	✓
object	✓	✓

Table 1: Adult-like grammaticality judgments for the 4 constructions at stake.

Hypotheses

- **H1 (general):** The difficulty with **TCs** is due the embedding of infinitival clauses. **TCs** should be as difficult as **GDPs**.
- **H2 (mildly specific):** The difficulty with **TCs** is due to **object**-gap dependencies. **Object-TCs** should be as difficult as **object-GDPs**, and more difficult than **subject-GDPs**.
- **H3 (very specific):** The difficulty with **TCs** is due to exceptional properties of those constructions (Improper Movement etc.). **TCs** should be more difficult than **GDPs** across the board.

The study

At a glance

- English-speaking kids aged 4 to 7, 40 per age group.
- **Elicited Imitation Paradigm: the ability to repeat a structure is seen as a proxy for having acquired it.**
- ∼30 minutes study conducted on Zoom using animated slides, with various breaks and rewards to keep the kid engaged.

Figure 1: Screenshot and script of a critical trial (**object**-**TCs**). Mama Cat and Baby Cat's voices were prerecorded.

Mama: Look! Bunny and Whale will have a race!
Baby: *meows*
Mama: Bunny can run fast, but Whale can't move on the ground.
Baby: *meows and falls asleep*
Mama: **Bunny is hard for Whale to beat __ .** Are you listening? **Bunny is hard for Whale to beat __ .** *exits*
Baby: *awakes and meows*
Experimenter: What did Mama Cat say when Baby Cat was sleeping?

Study specifics

Design

- 2 groups (between-subject): **subject**-gap (**S**) and **object**-gap (**O**).
- 4 training items of increasing difficulty (cf. Appendix slide 27)...
- followed by 3 randomized blocks with 3 items each (1×**TC**, 1×**GDP**, 1×**Control**), in various internal orderings (cf. Appendix slide 28).

Controls

- Controls depend on the group and are designed to counterbalance the proportion of adult-grammatical trials between groups ($\frac{2}{3}$).
  - **Subject**-gap group: adult-**grammatical** degree phrase containing an "overt" gap coreferential with the matrix subject (e.g., *Dog*$_1$ *is too short for him*$_1$ *to hug Eagle*).
  - **Object**-gap group: adult-**ungrammatical** "expletive" degree-phrase (e.g., *It is too high for Dog to hug Eagle*).
- **Controls** were also used as baselines for (un)grammaticality.

Reformulation of the hypotheses

Predicitons in an Elicited Imitation paradigm

- In an Elicited Imitation paradigm, the difficulty/ungrammaticality of a structure translates into a unability for the kid to repeat it.
- Coming back to our hypotheses:
  - **H1 (general):** the imitation rate of **object-TCs**, **object-GDPs**, and **subject-GDPs** should be the same, and higher than that of **subject-TCs**.
  - **H2 (mildly specific):** the imitation rate of **object-TCs** and **object-GDPs** should be the same, lower than that of **subject-GDPs**, and higher than that of **subject-TCs**.
  - **H3 (very specific):** the imitation rate of **TCs** should be lower than that of **GDPs** across the board.

Results and discussion

Exclusions

Exclusions using the training items

- In order to be included in the study, the kid had to repeat correctly at least 3/4 training sentences.
- Training trials could be repeated at most three times.

Age filtering

- 4 y.o.s had big difficulties completing the task, lots of them being excluded during training. Keeping this age group for the analysis would result in testing an unrepresentative sample of 4 y.o.s...
- 7 y.o.s were "too good" at the task, mimicking every structure, even the ungrammatical ones (cf. Appendix slide 29).
- **That is why we eventually chose to focus on 5 and 6 y.o.s.**
- This lead us to analyze the data of 45 participants in total, 21 5 y.o.s and 24 6 y.o.s.

Modeling

Coding

- For each trial ($3 \times 3 = 9$ per subject) the capacity to repeat the critical sentence was binary coded:
  - 0 (=success) if the structure (incl. gap position and predicate class) was retained modulo minor vocabulary changes or superficial simplifications;
  - 1 (=failure) otherwise.

Model

- Cumulative Link Mixed Models (`clmm`):
  - 3 main variables: `Age` (5/6), `Gap` (**S**/**O**), `Construction` (**TC**/**GDP**);
  - 2 random intercepts: (1|`participant`), (1|`trial`)
- We tested different interactions, (cf Table 2, next slide), and the best model was selected using the Akaike Information Criterion.

Model selection based on the Akaike Information Criterion

Model name	Interactions included			
	Age*Cons	Age*Gap	Cons*Gap	Age*Cons*Gap
m_ac	✓	✗	✗	✗
m_ag	✗	✓	✗	✗
m_cg	✗	✗	✓	✗
m_ac_ag	✓	✓	✗	✗
☞ m_ac_cg	✓	✗	✓	✗
m_ag_cg	✗	✓	✓	✗
m_acg	✗	✗	✗	✓

Table 2: Models tested. All included, in addition to the various interactions, the main variables Age, Cons, and Gap, as well as two random intercepts (1|participant) and (1|trial).

m_ac_cg:

$$\texttt{error} \sim \texttt{age} + \texttt{cons} + \texttt{gap} + \texttt{age} * \texttt{cons} + \texttt{cons} * \texttt{gap} + (1|\texttt{participant}) + (1|\texttt{trial})$$

Best model: Age*Cons and Cons*Gap interactions

Main effects

- Gap and Construction marginally significant ($p < .1$).
- Gap: $\oplus$ coefficient, means object-gap constructions tend to be more difficult;
- Cons: $\oplus$ coefficient, means GDPs are more difficult(!)

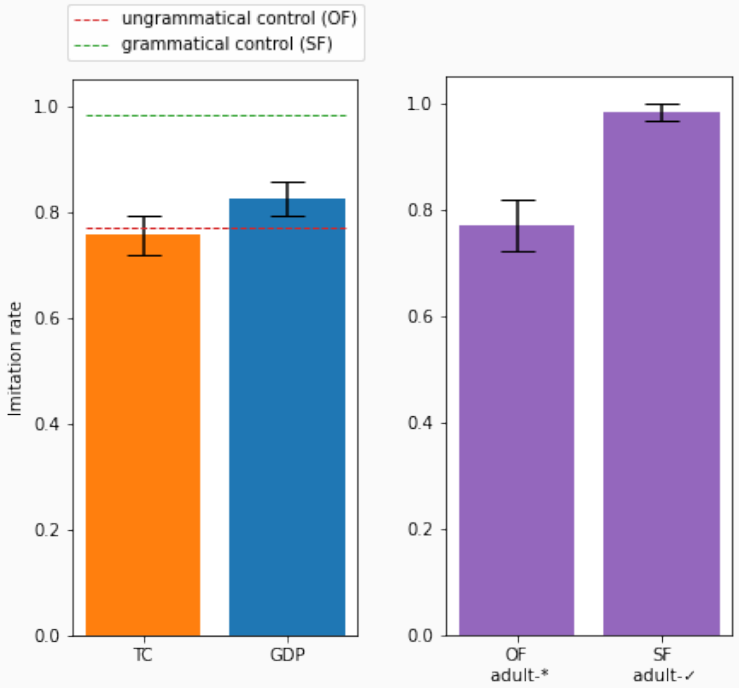
Variable	Coefficient estimate	p-value
Age	0.4358	0.4203
Cons	3.9661	0.0610
Gap	0.5457	0.0601
Age*Cons	-0.7890	0.0378
Cons*Gap	0.5263	0.0115

Table 3: Summary of m_ac_cg (clmm).

Interactions: Age*Cons and Cons*Gap significant ($p < .05$)

- Age*Cons: $\ominus$ coefficient, means older kids (6 y.o.) perform better on GDPs than younger kids (5 y.o.), and older kids perform less well on TCs than younger kids.
- Cons*Gap: $\oplus$ coefficient, means object-GDPs and subject-TCs are more difficult than subject-GDPs and object-TCs

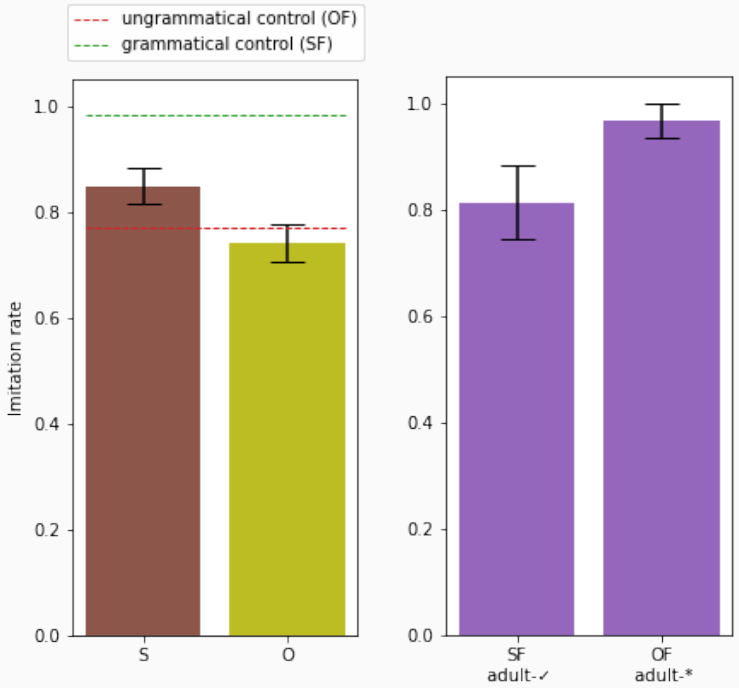
5+6 y.o.s. : effect of Construction



Observations

- Imitation rates are globally high (at least 80%), yet **grammatical** (SF) and **ungrammatical** (OF) **controls** still set clear baselines.
- Overall, **TCs** and **GDPs** are close to the **ungrammatical** filler.
- We need to look at the interaction plots (teasing apart **subject**- and **object**-gaps for each construction), to see what drives this result.

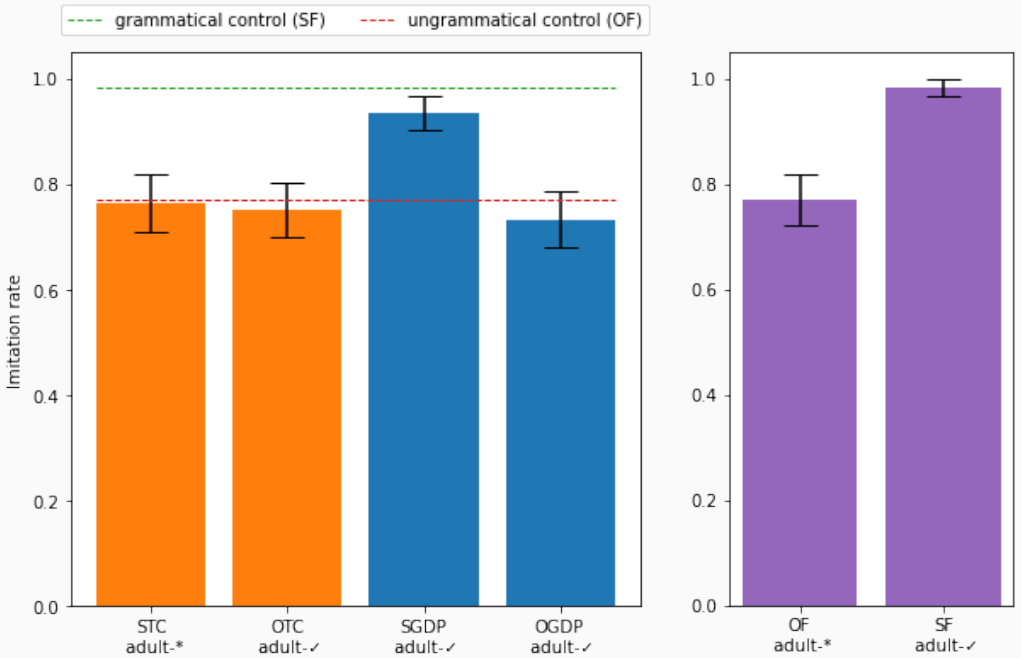
5+6 y.o.s.: effect of Gap



Observations

- Overall, **subject**-gaps are slightly easier to process than **object**-gaps.
- This is in line with previous findings on **object**-gap dependencies.
- The fact that adult-**ungrammatical subject**-**TCs** count as **subject**-gap structures might undermine the contrast.
- Let's now look at interaction plots to clarify this!

5+6 y.o.s. : Cons*Gap interaction



Observations

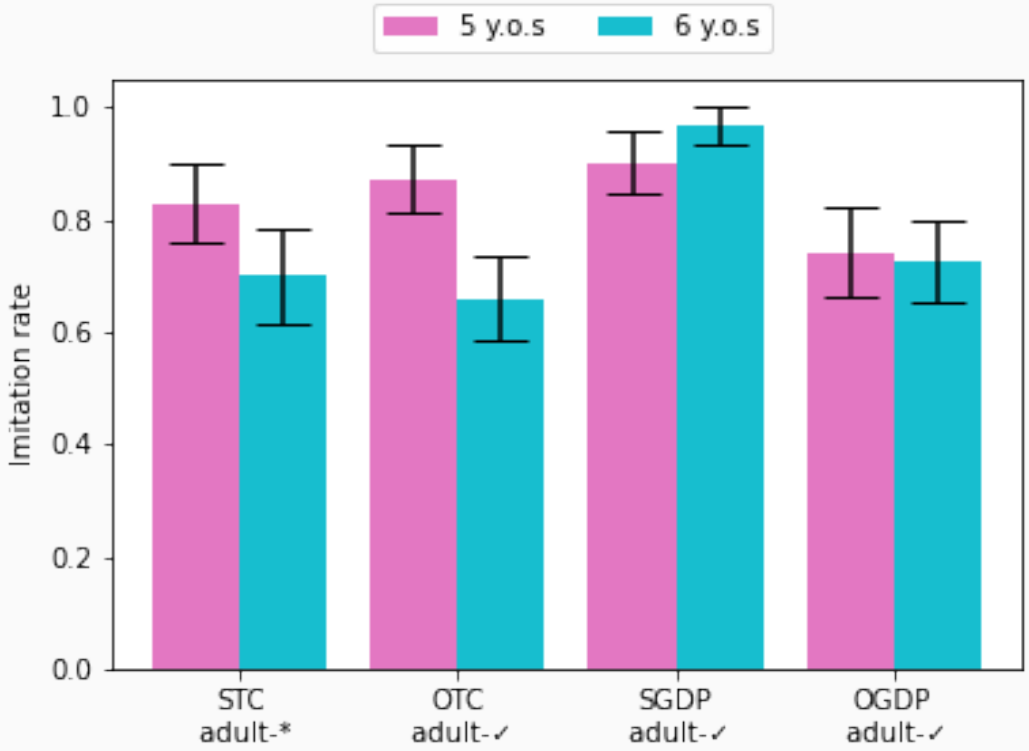
- Imitation rates on **TCs** (both **subject**- and **object**-gap) are indiscernible from those of **ungrammatical controls**.
- Significant contrast between **subject**- and **object-GDPs**:
  - **Subject-GDPs** pattern almost like **grammatical** controls (SF);
  - **Object-GDPs** pattern like **ungrammatical** controls (OF)!

Interim summary

TCs seem to be "tough" because of their object-gap!

- The pattern of **GDPs** supports the **subject-** *vs* **object-**gap processing asymmetry.
- The pattern of **TCs**, whereby **object-TCs** are just as difficult as **object-GDPs** and **subject-TCs**, seems to support H2, i.e., **the fact that TCs are hard because of the presence of an object-gap dependency.**
- Let us now try to confirm this conclusion by looking at age-by-age results.

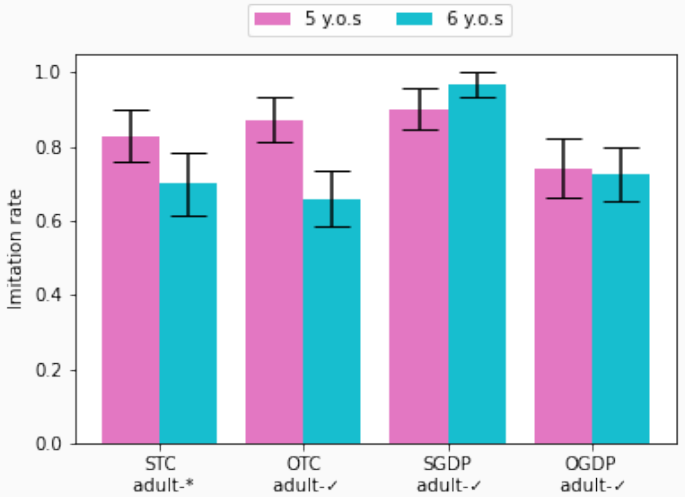
Age comparison



General observations

- **GDPs** follow the general pattern across age groups, with slightly less accuracy in the 5 y.o. group.
- For **TCs** however, we notice a drop in accuracy at age 6, for both **subject**- and **object**-gap constructions...

Age comparison



The case of TCs

- The lower imitation rate with **subject-TCs** in the 6 y.o. group is consistent with previous findings that children identify the ungrammaticality of those structures around that age.
- The lower imitation rate with **object-TCs** makes a little bit less sense (reanalysis?), although it supports the claim that the difficulty of **object-TCs** is not solely due to the **object**-gap dependency.
- This all points to the emergence of special difficulties with the syntax of **TCs**at 6 y.o, more in line with H3.

Conclusion

The difficulty of TCs has mixed origins

- By comparing **TCs** to **GDPs**, we confirmed that:
  - **Object**-gap dependencies are generally harder to process than **subject**-gap ones.
  - Kids start to get the syntactic difficulty of **TCs** at age 6.
- The difficulty of **TCs** seems to be caused primarily by their **object**-gap (H2), but also, to a certain extent, to special features (H3), as suggested by the age-by-age data.

Thank you!

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Appendices

TCs as Improper movement constructions

A-properties

- Φ-agreement of the matrix subject with matrix T, cf. (5a).
- No weak crossover effect [18], i.e., possibility for the matrix subject to "cross" a non C-Commanded coreferential pronoun, cf. (5b).
- The matrix subject constitutes a new potential antecedent for anaphor binding (feeds Principle A, cf. (6c) and [19]).
- The matrix subject does *not* constitute a new potential antecedent for pronoun binding (bleeds Principle C, cf. (5d) and [20]).

(5) a. Cette$_F$ décision$_F$ est importante$_F$ a prendre __.
'This decision is important to make'.

b. No employee$_1$ will be easy for us to get his$_1$ boss to fire __.

c. Jon and Mary were hard for each other$_1$'s friends to get along with.

d. Mary$_1$'s father is tough for her$_1$ to get along with __.

TCs as Improper movement constructions

Ā-properties

- Long-distance dependency between the matrix subject and the gap (cf. (6a) and [6]).
- Parasitic gap licensing (cf. (6b) and [21]).
- Island creation (cf. (6d) and [22]).

(6) a. Aspects was annoying to be asked by Joan to convince Matt to read __.

b. On Raising is easy to admire __ without having read pg.

c. Jon and Mary were hard for each other$_1$'s friends to get along with.

d. * Where$_1$ was Syntactic Structures$_2$ enjoyable [to read __$_1$ __$_2$].

TCs as a challenge for the θ-theory

(7) a. Suzi is **tough** for Joseph to talk to __ . **object-TC**

b. It is **tough** for Joseph to talk to Suzi. "expletive" **TC**

Avoiding Improper Movement leads to problems of θ-assignment

- An alternative to an Improper Movement approach to **TCs** is the so-called *base-generation approach* [21], [23], [24], whereby the gap is a null operator bound by the base-generated matrix subject.
- But the possibility of an "expletive" variant (cf. (7b)) of a regular **object-TC** suggests that the **tough**-predicate does not assign a thematic role to the matrix subject.
- So, the matrix subject receives its role from the embedded predicate... but this is mysterious under a base-generation account, since the matrix subject was never in the embedded clause!
- Additionally, the same θ-role would be shared by two elements: the matrix subject and the embedded null operator. This is unusual!

Training items

(a) Look! Today is Little Bunny's birthday. **He ate a cake.** Are you listening? **He ate a cake.**

(b) Look! Lily wants to make bread. Her grandma offered to help. **They are making bread together.** Are you listening? **They are making bread together.**

(c) Look! Today Bear visited his friend Masha. The weather is very beautiful. **He asked her to play outside.** Are you listening? **He asked her to play outside.**

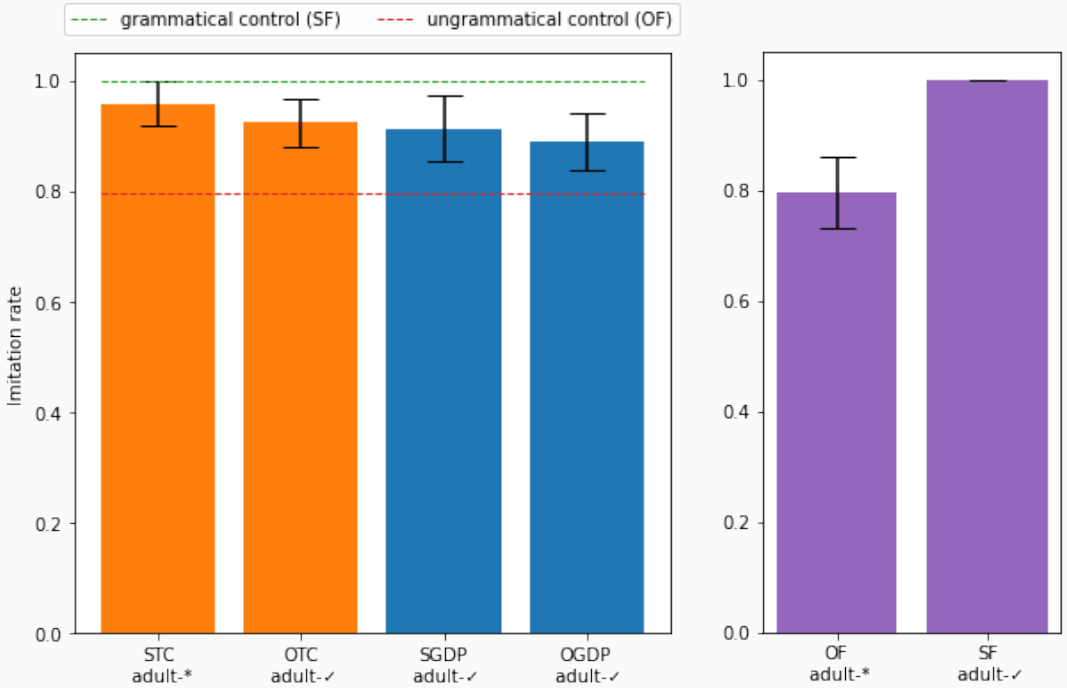
(d) Look! Hippo's cup is very small. Giraffe and Hippo are drinking juice outside. **Giraffe wants Hippo to drink more juice.** Are you listening? **Giraffe wants Hippo to drink more juice.**

Block randomization

Block label	Internal ordering		
	1st	2nd	3rd
A	**TC**	**F**	**GDP**
B	**F**	**GDP**	**TC**
C	**GDP**	**TC**	**F**

Ordering label	Block ordering		
	1st	2nd	3rd
1	A	B	C
2	A	C	B
3	B	A	C
4	B	C	A
5	C	A	B
6	C	B	A

7 y.o.s.



Observations

- Very high accuracy on all constructions, including **subject-TCs**.
- We suspect that 7 y.o.s could simply mimick the sentences by keeping them in their short term memory; s.t. their ability to repeat is not a sign that they acquired the structure (background assumption of the Elicited Imitation Paradigm...)