

# COULD THE SUBJECT BE A BIG PRO?

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# Abstract

Reactivation at trace positions has gained recent experimental support, and this may extend to PRO positions. Hestvik et. al. (2010) and Nicol and Swinney (1989) have worked on referent reactivation and its relationship to syntactic processing. PRO, an implicit anaphoric element, has inspired debates over its characterization properties and its relationship to other sentential elements. Chomsky's PRO theorem (1981) states that PRO must be ungoverned, assuming PRO to be caseless. Yet, PRO's case assignment has shown to be language dependent (Sigurðsson et. al., 2008; Sportiche et. al., 2013, inter al.). This suggests that looking further into reactivation patterns is necessary in order to understand the structure of PRO.

Our experiment sampled priming effects, compared to a baseline, from twenty participants presented with the task of identifying images of possible or impossible PRO antecedents. Images were presented at one of three positions in object or subject control sentences in Norwegian, in a controlled randomized sequence. The positions were either (a) before or (b) after the infinitive marker, or (c) at the end of the sentence. These positions represent the position of PRO in (a) S-structure or (b) D-structure and an unrelated position (c).

Object-control: *Flodhesten frarådet alligatoren (a) å (b) gå til festen (c).*

The hippo warned the alligator to go to the party.

Subject-control: *Sjiraffen lærte av elefanten (a) å (b) drikke fra elva (c).*

The giraffe learned from the elephant to drink from the river.

Results indicated weak effects: The strongest indication was an effect of position approaching significance. Post hoc investigation of the median of the priming effect at each position for object and subject control showed a priming effect (between 85 and 10ms, 95%CI), but only for subject-control at position (b), after the infinitive marker (Cohen's  $d=1.2$ ,  $r=0.5$ ).

The experiment points to reactivation related to PRO after the infinitive marker exclusively for subject-control. At this position, most participants showed priming. This provides evidence for claiming that PRO is a reflexive subject, based on behavioral properties and position reactivation. It also suggests that experimental evidence is essential in investigations of PRO and its case and thematic role assignment, especially as reactivation patterns show constraints that are not compatible with general trace activation.

# What is big PRO?

- An implicit element that takes the place of a subject in a dependent clause of a control structure and draws its meaning from another DP.
  - *A null (silent) DP found in caseless positions.* \*\*
    - Later assigned Null case (Chomsky & Lasnik, 1993)
  - *Does not involve DP movement out of its clause.*
  - *[+ pronominal, + anaphor]* (Chomsky, 1981)

\*\* The Case of PRO has been found to be language dependent.

*Jean<sub>i</sub> is reluctant PRO<sub>i</sub> to leave.*

*Jean persuaded Brian<sub>j</sub> PRO<sub>j</sub> to leave.* (Carnie, 2013)

# PRO in Control Structures

- **Subject-control**: A sentence where there is a PRO in the embedded non-finite clause that is controlled by the subject argument of the main clause.
  - *Ex: John<sub>i</sub> is reluctant PRO<sub>i</sub> to leave.*
- **Object-control**: A sentence where there is a PRO in the embedded non-finite clause that is controlled by the object argument of the main clause.
  - *Ex: John persuaded Bill<sub>j</sub> PRO<sub>j</sub> to leave.*
- **Arbitrary PRO**: Uncontrolled PRO which takes an arbitrary reference.
  - *Ex: PRO<sub>arb</sub> To find a new mate, go to a dating service.*

(Carnie, 2013)

# PRO in Binding Theory

Binding Theory: A theory of the syntactic restrictions on where different NP types can appear in a sentence.

- *Principle A*: An anaphor must be bound in its binding domain (the clause containing the NP).
  - *PRO does not always follow the locality constraints for anaphors.*
- *Principle B*: A pronoun must be free in its binding domain.
  - *PRO has instances where it is obligatorily bound in its binding domain.*
- *Principle C*: An R-expression must be free/unbound.
  - *PRO is not always free. Control can be optional or obligatory.*

Jean<sub>i</sub> tried PRO<sub>i/j\*</sub> to behave.

(Carnie, 2013)

# Control Theory—The PRO Theorem!

- Used to explain how PRO gets its meaning since this cannot be done by the Binding Theory.
  - *The meaning of PRO is not only determined by its syntactic and thematic properties. Pragmatic knowledge also plays a role. (Carnie, 2013)*
  - *Government is introduced to the Binding Theory. Binding domain is termed governing domain.*
  - *PRO is ungoverned and, therefore, does not have a governing domain!*
    - Can be [+ pronominal, + anaphor] without obeying binding constraints. (Chomsky, 1981)

# PRO as a Subject

- Sits in the TP spot of a clause and acts as its subject.
- PRO is found to have language dependent qualities, such as case (Sigurðsson et. al., 2008; Sportiche et. al., 2013, inter al.).
  - *How can PRO be ungoverned and still carry case?*
- Though PRO is in the subject position, its referent can be in the subject or object position.

Can PRO be considered the subject of controlled infinitival clauses?

How would PRO being classified as a subject affect the definition of a universal subject?

Can this be shown using experimental research?

# Previous Research on NP, Pronoun, and PRO Reactivation

- Referent reactivation and its relationship to syntactic processing:
  - *Hestvik et. al. (2010)*
    - Found immediate gap filling in children accompanying trace positions of relativized object nouns occurring in relative clauses.
  - *Nicol and Swinney (1989)*
    - Found immediate reactivation of wh-traces but delayed reactivation for PRO.
    - Antecedent reactivations are possibly linked to the complexity of the theoretical constraints associated with each type of anaphora.
- The relationship between theories of grammar and parsing:
  - *Walinski (2002)*
    - Found priming and infinitival complement expectancy difference between subject-raising and subject-control. Found no difference in the structure of the complements.
    - It is possible that theories of grammar and parsing can be mutually constraining.

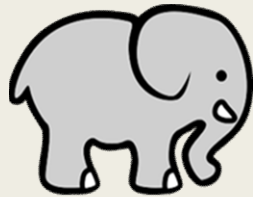


# Our Experimental Research

- Participant reaction times were collected to analyze the reactivation patterns and priming effects of PRO antecedents.
  - *These patterns give insight on the role of PRO as a clause subject and the interaction of constraints affecting PRO referent assignment.*
- **Null hypothesis**: There is no reactivation effect for PRO referents throughout sentence processing.
- **Alternative hypothesis**: PRO is reactivated after the infinitive marker specifically in instances of subject-control.

# Experimental Method and Design

- 20 native speakers of Norwegian
- 12 test sentences
  - 4 object-control, 4 subject-control, 4 unrelated
  - All containing two possible antecedents
- 4 animal images of possible antecedents:



# Experimental Method and Design

- Sentences were displayed in a random order and word-by-word, with each word shown for 500ms.
- Images of possible and impossible PRO antecedents were presented for a maximum of 3000ms (or until a participant response was recorded) at three different positions throughout the timed reading sequence.
  - *One position per sentence presentation, with a total of 144 sentence presentations per participant.*

## **Object-control:**

*Flodhesten frarådet alligatoren (a) å (b) gå til festen (c).*

The hippo warned the alligator (a) to (b) go to the party (c).

## **Subject-control:**

*Sjiraffen lærte av elefanten (a) å (b) drikke fra elva (c).*

The giraffe learned from the elephant (a) to (b) drink from the river (c).

# Experimental Method and Design

- Position (a): Position of PRO in S-structure; subject element position.
- Position (b): Position of PRO in D-structure; position of origin of subject element.
- Position (c): Unrelated position used to test for delayed reactivation or processing of PRO referent.

## **Object-control:**

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## **Subject-control:**

*Sjiraffen lærte av elefanten (a) å (b) drikke fra elva (c).*

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# Experimental Method and Design

- Subjects were asked to decide whether or not they had been exposed to the animal image before in the sentence (in word form).
  - *A red button was pressed for 'no' and a green button for 'yes'.*
- In between each sentence presentation, a line of asterisks were presented as a fixation point and also as a physical separation between each presentation.
- Before data collection began, training sentences were used to create an association between word and picture as well as to get the participant familiar with the task.

# Participant Experience

Sjiraffen lærte av elefanten  å drikke fra elva .

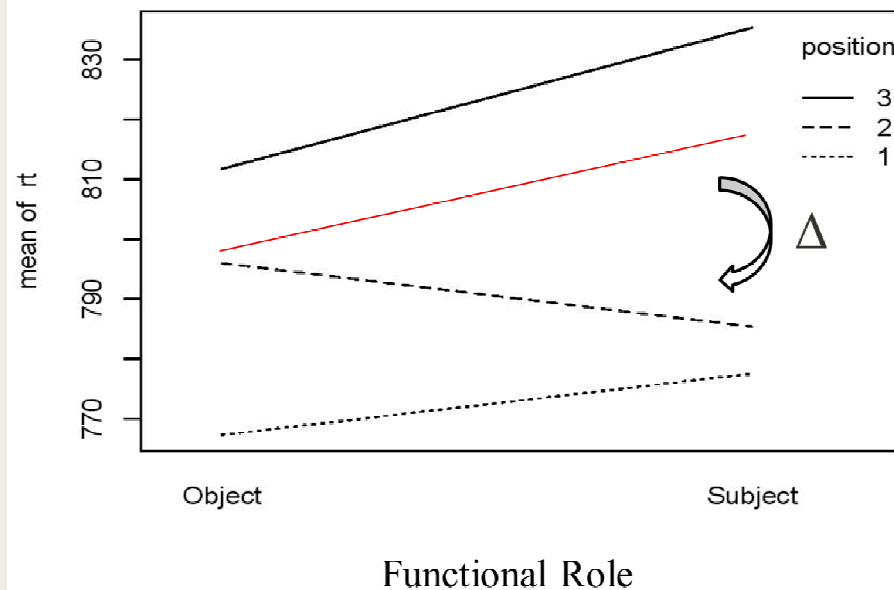
\*\*Presses 'yes' or 'no'

# Results

- Initial results analysis using Lmer models in R showed weak effects.
  - *Only an effect for position approaching significance.*
- A post hoc investigation was done using t-tests with a focus on position using the median of the priming effect at each position for object and subject.
  - *A priming effect (between 85 and 10ms, 95%CI) was found explicitly for subject-control at position 2 (b), after the infinitive marker (Cohen's  $d=1.2$ ,  $r=0.5$ ).*

# Results

## ■ Priming Effects for Position x Functional Role:



The mean reaction time for position 2 (b), after the infinitive marker, decreases in instances of subject-control.

All other positions do not display an effect. In positions 1 and 3 (a and c), object-control has a faster mean reaction time trend. This can be explained due to linear distance.

\*\*The inserted red line displays the assumed data values if the data was to follow the trend of the furthest antecedent taking longer to reactivate.



# Results Interpretation

- Reactivation of PRO after the infinitive marker seems to apply strictly to subject-control.
- It is possible that PRO is processed in its position in D-structure, before being moved to the TP position as a subject.
- Is PRO activated by the infinitive marker? Is an infinitive marker necessary for reactivation of PRO referents?
  - *Does this relate to the claim that case is assigned by non-finite T (Chomsky & Lasnik, 1993)?*
  - *Further research must be done on languages like Spanish and Italian that have PRO but no infinitive markers.*

# PRO and Subjecthood

- The reactivation of PRO referents only in cases of subject-control suggests that infinitive clauses have PRO as a formal subject element in control structures.
  - *To what degree does PRO being a subject affect the definition of a universal subject?*
    - Is PRO a basic subject of a semantically basic sentence?
      - *The infinitive clause depends on the matrix clause for referential meaning.*
      - *Are there semantically more basic sentences of this type?*
    - How can coreference with a basic subject affect PRO's subject status?
      - *To what extent does the basic subject pass on its properties?*
      - *Can research compared from languages provide support for the order of the Promotion to Subject Hierarchy (Keenan, 1976)?*

# How can understanding Subjecthood help us to understand PRO?

- Different frameworks have different ideas of subjecthood.
- It is possible that by following the Promotion to Subject Hierarchy, PRO is only assigned certain subject characteristics based on language.
  - *Usually semantic properties are assumed last in a derived subject.*
  - *“We know of no clear cases in which derived subjects become e.g. agents.” (Keenan, 1976)*
- Subjects really don't have to be case-marked?
  - *Language dependent for PRO.*
  - *Possibly not a coding property inherited by PRO.*

# How can understanding Subjecthood help us to understand PRO?

- Basic subjects are the easiest NPs to stipulate the coreference of across clause boundaries (Keenan, 1976).
  - *Basic subjects are the most reluctant of the major NPs to abandon their reference.*
  - *Faster reaction time for subject-control?*
  
- How can PRO go from subject to object-control if it is a subject?
  - *Does PRO have control of “switch reference” indicators (Keenan, 1976)?*

# Necessary Further Research

- Cross-linguistic experimental research
  - *Focusing on differences between languages, especially between those with case-marked and Null case PRO.*
  - *Is case assigned differently or are there different PROs across languages?*
- Second language effects on PRO processing
  - *Is referent assignment a learned process that uses more general cognitive functions?*
  - *Or is it based in one's native language grammar?*
- Focus on reactivation only for subject-control structures
  - *Test with a larger number of participants and less experimental factors.*
  - *Will results replicate?*

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