Reading Clarifies Acquisition: A study on subject-object asymmetries

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FCSH

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Conferência Internacional:
Leitura - Processamento da Língua Escrita
Overview

i. Subject-object asymmetries in the acquisition of dependencies.
ii. Subject-object asymmetries in reading.
iii. Relevance for acquisition of assessing reading.
Subject-object asymmetries are well documented in the acquisition of syntactic dependencies.
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Relative Clauses (RC).
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*wh*-questions.
Background

- Subject-object asymmetries are well documented in the acquisition of syntactic dependencies.
- Relative Clauses (RC).
- *wh*-questions.

(Adams, 1990; Adani, 2008, 2011; Brown, 1972; Contemori and Garraffa, 2010; Corrêa, 1982, 1995; Costa et al., 2011; de Villiers et al., 1994; De Vincenzi, 1991; Friedmann et al., 2009; Friedmann and Novogrodsky, 2004; Håkansson and Hansson, 2000; McKee et al., 1998; Roth, 1984; Sheldon, 1974; Tavakolian, 1981; Vasconcelos, 1991).

(1) \[ \text{DP}_{\text{Object}} \text{ [DP}_{\text{Subject}} \text{ [V <DP}_{\text{Object}> ]} ] \]
Friedmann et al. (2009):

- Asymmetries in comprehension of subject and object relatives in headed relative clauses, but not in free relative clauses.

This follows from RM effects.

Free relative operator does not share features with intervening DP.
Experiment 1: Method

Goal: assess differences between free and headed wh-dependencies in children acquiring European Portuguese.

- Methodology: Sentence to Picture Matching Task
- 2x2 crossing headedness (headed vs. free) and extraction site (subject vs. object)
Experiment 1: Materials

Example of materials (only reversible sentences were used)

(2) a. *Headed subject relative*
Mostra-me o menino que seca o hipopótamo
Show-me the boy that dries the hippo.

b. *Headed object relative*
Mostra-me o menino que o hipopótamo seca
Show-me the child that the hippo dries

c. *Free subject relative*
Mostra-me quem seca o hipopótamo
Show me who dries the hippo.

d. *Free object relative*
Mostra-me quem o hipopótamo seca
Show me who the hippo dries
Experiment 1: Participants

Participants:
- 40 monolingual TD children;
- Age range: 4;0-5;11
- 21 boys; 19 girls

Controls:
- 20 adults as control;
- Age range: 24-47
- 9 male; 11 female
Experiment 1: Results

<table>
<thead>
<tr>
<th></th>
<th>Headed Relatives</th>
<th>Free Relatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Object</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table: Control group results

Adults performed at ceiling in all conditions.
Experiment 1: Results

Group Results for children:

<table>
<thead>
<tr>
<th></th>
<th>Headed Relatives</th>
<th>Free Relatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>98,1%</td>
<td>94%</td>
</tr>
<tr>
<td>Object</td>
<td>81,8%</td>
<td>82,25%</td>
</tr>
</tbody>
</table>

**Table:** Children’s group results
# Experiment 1: Results

<table>
<thead>
<tr>
<th></th>
<th>Headed Relatives</th>
<th>Free Relatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject</strong></td>
<td>96,5%</td>
<td>91,5%</td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>76,75%</td>
<td>83,5%</td>
</tr>
</tbody>
</table>

**Table:** 4 y.o. children’s results

<table>
<thead>
<tr>
<th></th>
<th>Headed Relatives</th>
<th>Free Relatives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject</strong></td>
<td>99,75%</td>
<td>96,5%</td>
</tr>
<tr>
<td><strong>Object</strong></td>
<td>87%</td>
<td>87%</td>
</tr>
</tbody>
</table>

**Table:** 5 y.o. children’s results
As a group, children performed *above chance level* in all conditions.

A repeated measure ANOVA crossing *headedness* (headed vs. free) with *extraction site* (subject vs. object)

- Significant effect of the extraction site $F(1, 19) = 44.812, p < .0001,$
Analysis

As a group, children performed *above chance level* in all conditions.

A repeated measure ANOVA crossing *headedness* (headed vs. free) with *extraction site* (subject vs. object)

- Significant effect of the extraction site $F(1, 19)= 44.812, p < .0001$,
- No effect of the headedness $F(1,19)= .668, p = .42$. 
As a group, children performed *above chance level* in all conditions.

A repeated measure ANOVA crossing *headedness* (headed vs. free) with *extraction site* (subject vs. object)

- Significant effect of the extraction site $F(1, 19)= 44.812, p < .0001$,
- No effect of the headedness $F(1,19)= .668, p = .42$.
- Significant interaction between the two factors $F(1, 19) = 12.340, p = .002$. 
Experiment 1: Analysis of Interaction

Extraction site significant in both headed $F(1, 19) = 60.350$, $p < .0001$, and free movement, $F(1, 19) = 9.651$, $p = .006$;
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Extraction site significant in both headed $F(1, 19)= 60.350 \ p < .0001$, and free movement, $F(1,19)= 9.651, \ p=. 006$;

Significant effect of headedness in opposite directions in subject and object extraction:
Experiment 1: Analysis of Interaction

Extraction site significant in both headed $F(1, 19)= 60.350$ $p < .0001$, and free movement, $F(1,19)= 9.651$, $p=.006$;

Significant effect of headedness in opposite directions in subject and object extraction:

- subject RCs significantly better in headed than free condition;
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Extraction site significant in both headed $F(1, 19)= 60.350$ $p < .0001$, and free movement, $F(1,19)= 9.651$, $p=. 006$; Significant effect of headedness in opposite directions in subject and object extraction:

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- object RCs significantly better in free than headed condition.
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Extraction site significant in both headed $F(1, 19)= 60.350 \ p < .0001$, and free movement, $F(1,19)= 9.651, \ p= .006$;

Significant effect of headedness in opposite directions in subject and object extraction:

- subject RCs significantly better in headed than free condition;
- object RCs significantly better in free than headed condition.

This might be responsible for the apparent lack of headedness effects.
Summary of Experiment 1

Summarizing the results, we found:

a. Above chance performance in all conditions.
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b. Better comprehension of subject than object extraction.
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c. Asymmetry between free and headed extraction in object at 4 y.o. only; with better performance of free object than headed object.
Summary of Experiment 1

Summarizing the results, we found:

a. Above chance performance in all conditions.

b. Better comprehension of subject than object extraction.

c. Asymmetry between free and headed extraction in object at 4 y.o. only; with better performance of free object than headed object.

d. Latter advantage disappears at 5 y.o.
Complexity of object movement

- Object extraction more complex than subject extraction

- Notable exception of Basque Carreiras et al. 2010
Persisting effect of subject-object asymmetry at age 5 is due to:

- Processing difficulties induced by the RM effect?
- A late development of wh-dependencies?

Predictions:

- Complexity effects should occur in adults too;
- Developmental effects should not occur in adults.

Hypothesis:

- Similar effects should be observed in adults using more sensitive techniques.
Experiment 2: Method

Self-paced reading task with adults to assess:

- Subject-object asymmetries in reading wh-dependencies;
- Free-headed asymmetries in reading wh-dependencies.
Experiment 2: Materials and Design

- 2x2 crossing *Headedness* (headed vs. free) and *emphExtractionSite* (subject vs. object)
- 20 sets of target sentences (4 versions each)
- 60 fillers
Experiment 2: Stimuli

(3)  

a. *Free subject dependency*
   A advogada contou ao juiz quem estava a corromper o politico com dinheiro público

b. *Free object dependency*
   A advogada contou ao juiz quem o politico estava a corromper com dinheiro público

c. *Headed subject dependency*
   A advogada contou ao juiz que politico estava a corromper o presidente com dinheiro público

d. *Headed object dependency*
   A advogada contou ao juiz que politico o presidente estava a corromper com dinheiro público
Experiment 2: Procedure

- word-by-word self-paced reading paradigm (Just et al., 1982), approx. 20 minutes
- Counterbalanced materials (each subject only sees one version of each sentence)
- PC using Linger software developed by Doug Rodhe (http://tedlab.mit.edu/dr/Linger)
- Comprehension questions following EACH sentence
- White noise
Experiment 2: Participants

Participants

26 Native Speakers of EP students and staff members of the UNL, only one subject excluded from analysis (chance performance on Qs: 46.5%)
Experiment 2: Results

Comprehension Questions: 79.8% correct
2x2 repeated measure ANOVA by subjects crossing headedness and extractionsite

<table>
<thead>
<tr>
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<th>Free</th>
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<tbody>
<tr>
<td>Subject</td>
<td>77.6%</td>
<td>87.2%</td>
</tr>
<tr>
<td>Object</td>
<td>64.0%</td>
<td>90.4%</td>
</tr>
</tbody>
</table>

Table: Percentage of correct answers
Experiment 2: Analysis of Qs

2x2 repeated measure ANOVA crossing headedness and extraction site

- Significant effect of headedness. Headed significantly harder to comprehend than free both over subject (70.8% vs. 88.8%, $F(1, 24)=27.000, p < .001$) and items ($F(1, 19)=25.396, p < .001$).

- Significant interaction
  
  headeness*extraction by item ($F(1, 19)=6.257p = .022$) and close to significance in the analysis by subject ($F(1, 24)= 2.725 p = .112$)

- better performance with free object than headed object extraction.
Experiment 2: Reading Times

- Residual reading times were calculated (Ferreira and Clifton 1986; Trueswell et al. 1994)
- Mixed Model Regression analysis in open-source code R with the lme4 library (Bates and Sarkar, 2007)
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- Significant effect of headedness ($t$ value $= 4.215$): shorter RTs for free than headed dependencies.
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- Residual reading times were calculated (Ferreira and Clifton 1986; Trueswell et al. 1994)
- Mixed Model Regression analysis in open-source code R with the lme4 library (Bates and Sarkar, 2007)
- Significant effect of headedness (t value = 4.215): shorter RTs for free than headed dependencies.
- Significant effect of extractionsite (t value = -3.329): shorter RTs for subject extraction than object extraction.
Subject-object asymmetries emerge in adults and in children, but in different tasks;

Reading comprehension is affected by different types of dependencies;

Finding of harder reading performance in object dependencies favors processing approach to the late development of object relatives and wh-questions.
Thank you!

Acknowledgments:

- Andrea Santi
- Ciência 2008


Carreiras, Manuel, Jon Andoni Duanobeitia, Marta Vergara, Irene de la Cruz-Pava, and Itziar Laka. 2010. Subject relative clauses are not universally easier to process: Evidence from Basque. *Cognition* 115:79–92.


Friedmann, Na’ama, and R. Novogrodsky. 2004. The acquisition of


Just, Marcel A., Patricia A. Carpenter, and Jaqueline D. Woolley.


