Feature Retrieval Cost and on-line/off-line complexity in clefts

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Theoretical background: retrieving the correct item in Object Clefts

Resolving the dependency between the head ("the banker", (1.a)) and the lexical verb ("avoided", (1.a)) is crucial to comprehend correctly an **Object Clefts** (**OCs**, e.g. (1)). This kind of dependency has been deeply studied both from the theoretical/competence perspective (Friedmann et al 2009, Belletti & Rizzi 2012 a.o.) and from the psycholinguistic/performance one (Gordon et al. 2001, 2004, a.o.), especially when an intervening "similar" DP (the subject of the cleft: "the lawyer" in (1.a) vs. "Dan" or "we" in (1.b)) is processed between the head and the lexical verb (Warren & Gibson 2005):

(1) a. it was ***[the banker]***$_i$ that ***[the lawyer]*** avoided **_**$_i$ at the party

b. it was ***[the banker/Pat/you]***$_i$ that **[the lawyer/Dan/we]** avoided **_**$_i$ at the party

Research questions

1. Evaluating a **feature-based** "**complexity metrics**" for predicting processing asymmetries in precise and graded way (possibly reconciling formal theory of competence and psycholinguistic performance)
2. Testing the role of **person features** (third (default) vs. second person as in (1.c)) when the "lexical restriction" (i.e. a full noun, Belletti & Rizzi 2012) is present:

(1) c. it was ***[the/you banker]***$_i$ that ***[the/you lawyer]*** avoided **_**$_i$ ***...***

Core proposal: FRC function

$$\mathbf{FRC}(x) = \prod_{i=1}^{m_x} \frac{(1+nF_i)^{m_i}}{(1+dF_i)}$$

Feature Retrieval Cost (FRC) provides a numeric measure of the complexity on a specific segment triggering retrieval (e.g. the verb segment *x*) that is inversely proportional to the number of features unambiguously cued by the segment morphology (*dF*) and proportional to the number of features to be retrieved (*nF*) that are shared by other items in working memory (*m*).

Methods

Materials: 2x2 design: restriction (determiner (the) vs. pronominally restricted (you) NPs) x position (head vs subject cleft) (8 items per condition)

Sono/siete [$_{DP1}$ gli/voi architetti] che [$_{DP2}$ gli/voi ingegneri] [$_{verb\ region}$ hanno/avete consultato _] [$_{spill\text{-}over}$ prima di iniziare i lavori].
are$_{3P_PL}$/are$_{2P_PL}$ the/you architects that the/you engineers have$_{3P_PL}$/have$_{2P_PL}$ consulted before beginning the work

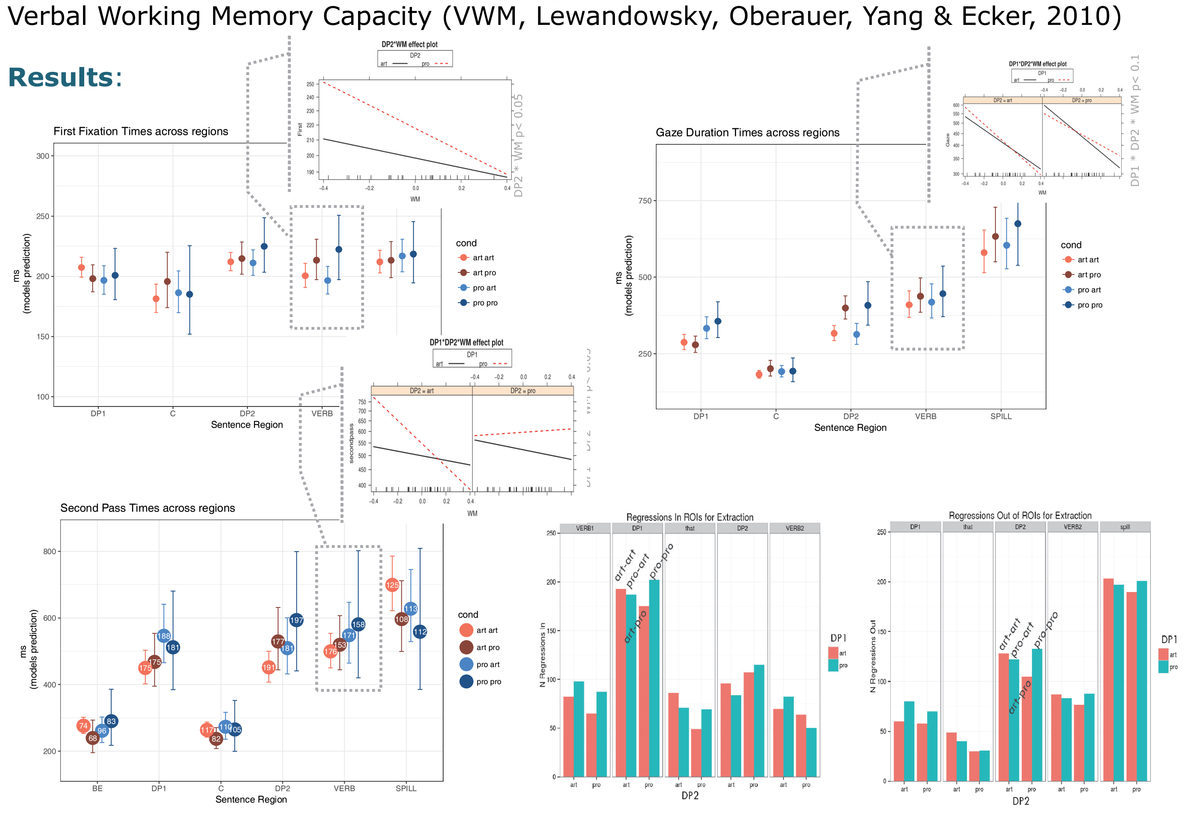
Art condition features: {+D, +num_pl, N} **Pro** condition features: {+D, +2P, +num_pl, N}

On-line (eye-tracking – Eyelink 1000)

Participants: 33 subjects (age range = 19-35; 18 female; centre-north Italian native speakers)

Procedure: On-screen sentence reading + comprehension question. After the task, Verbal Working Memory Capacity (VWM, Lewandowsky, Oberauer, Yang & Ecker, 2010)

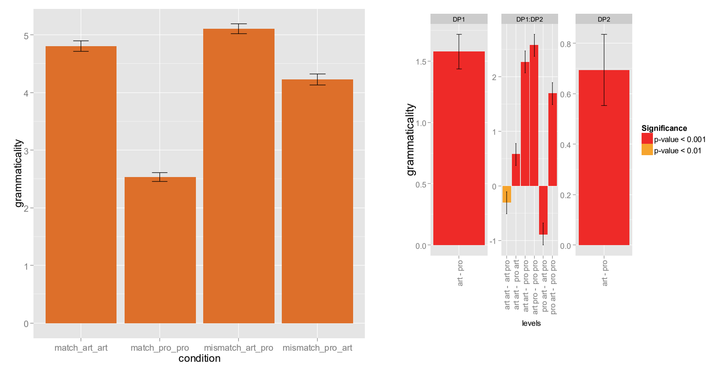
Results:



Off-line (grammaticality judgment – 7-points Likert)

Participants: Other 48 subjects (age range: 20-64; 25 females; centre-north Italian native speakers)

Procedure: grammaticality judgments (web-based questionnaire to evaluate sentences on a 7-points Likert-scale) on the very same materials



Eye-Tracking experiment accuracy:

DP1	DP2	Accuracy
art	art	83%
art	pro	90%
pro	pro	77%
pro	art	82%

FRC prediction

art pro (8) < art art (16) ≈ pro art (16) < pro pro (25)

Previous on-line evidence supporting FRC

Data from: Warren & Gibson (2005) self-paced reading experiment with Object Clefts. Materials are variations of (1.b).
Reading time at verb segment reported in the table below:

condition	D-D	D-N	D-P	N-D	N-N	N-P	P-D	P-N	P-P
Read. time (SE) ms	365 (19)	319 (12)	306 (14)	348 (18)	347 (21)	291 (14)	348 (18)	311 (15)	291 (13)
prediction	16	12,25	4,5	12,25	16	4,5	9	9	1

Predictions are obtained by applying **FRC** to these features:

D features (e.g. "the banker"): {+D, +num_sing, N}
N features (e.g. "Ben"): {+D, +num_sing, N_prop}
Pro features (e.g. "we"): {+D, +pers_I, +num_plur, +case_nom}

e.g.
D-D matching ("it was the lawyer$_{\{+D,\ +num_sing,\ N\}}$ that the businessman$_{\{+D,\ +num_sing,\ N\}}$ avoided...")
FRC (avoided) = ***16*** that is 16 · 1 (second item retrieval will always cost 1 when just 2 items were in memory!):
16 for retrieving "the businessman": nF=3, m=2 (because two Ds are in memory at that retrieval time), and dF=0 (because no feature is cued by the verb distinguishing one D from the other);
1 for retrieving "the lawyer": nF=0, m=1 and dF=0

P-P matching ("it was you$_{\{+D,\ +pers_II,\ +num_sing,\ +case\}}$ that we$_{\{+D,\ +pers_I,\ +num_plur,\ +case_nom\}}$ avoided...")
FRC (avoided) = 1 that is 1 · 1:
1 for the "we": nF=1, m=2 and dF=1 (number, person and case mismatches are always present; case is cued by the verb)

Discussion

Accuracy and acceptability as well as the major asymmetries in fixation times/regressions revealed are predicted by the FRC function (Chesi 2015). Pronouns (unlike articles) bear **2nd person features** on the intervening subject triggering verbal agreement and FRC relies on the distinct featural person disambiguation cued by the verbal morphology.

Results summary

On-line
First fixation on verb segment
art < pro (DP2 main effect)
Second Pass on verb segment
DP1 x DP2 x WM DP1 is pro and DP2 is art: in pro art, low WM
art pro ≈ art art < pro art ≈ pro pro

Off-line
Accuracy in comprehension questions
art pro > art art ≈ pro art > pro pro

Grammaticality judgment test
art pro > art art > pro art > pro pro

FRC
art pro < art art ≈ pro art < pro pro

Revealed overall
[simpler/more acceptable]
art pro < art art ≤ pro art < pro pro
[harder/less acceptable]

Selected references

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AMLAP – 6-9 Sep 2017
Lancaster (UK)