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INTERVENTION EFFECTS IN WH-ISLANDS: AN EYE-TRACKING STUDY

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BACKGROUND AND AIM OF THE STUDY

Long-distance dependencies are constrained both by syntactic and memory constraints.

- On the side of grammar, **Relativized Minimality [RM; 1,2]** states that the local relation between an **extracted element** and its trace is disrupted when it crosses an **intervening element** whose morphosyntactic featural specification **fully matches** that of the elements it separates:

(1) ***What**_{+Q} do you wonder **who**_{+Q} built ___? **FULL MATCH**

(2) ?**Which building**_{+Q,+N} do you wonder **who**_{+Q} built ___? **PARTIAL MATCH**

(3) **What**_{+Q} do you believe that **the engineer**_{+N} built ___? **ZERO MATCH**

- On the side of the cognitive psychology of memory retrieval mechanisms, the **cue-based Memory Model [MM; 3]** states that long-distance dependencies require the retrieval of the extracted element at the verb. Retrieval is driven both by **syntactic and semantic cues** triggered by the verb which enable direct access

to the relevant memory representation [4]. The probability of successfully retrieving the intended representation is determined by the feature match between the target (i.e. the **extractee**) and the probe (i.e. the verb), and by the feature distinctiveness between the target and irrelevant memory representations (i.e. the **intervener**).

Several acceptability studies conducted in English and French [5,6] showed that sentences with two lexically restricted wh-elements (4) are more acceptable than those with two bare wh-elements (1), even though in both cases the **intervener** has the same featural specification as the **extractee**:

(4) ?**Which building**_{+Q,+N} do you wonder **which engineer**_{+Q,+N} built ___?

This finding, difficult to account for by RM, is explained by MM as resulting of the greater semantic distinctiveness of lexically restricted wh-elements contributing to reduce retrieval interference. However, there is no direct evidence to date that the effect observed in off-line acceptability judgments of wh-islands is indeed due to an easier retrieval of the extractee at the verb. If this explanation is correct, a reduced processing cost is expected at the verb (or the adjacent spillover region) when the extractee is lexically restricted. The present study tests that prediction in an acceptability judgment study in Italian combined with an eye-tracking study.

METHOD

Participants: 37 Italian-speaking adults for the acceptability study; 36 Italian-speaking adults for the eye-tracking study

Materials: 4 sets of 4 sentences each

Variables manipulated: (1) Lexical restriction of the extracted wh-element Wh1 (Bare vs. Restricted)
(2) Lexical restriction of the intervening wh-element Wh2 (Bare vs. Restricted)

Wh1	Wh2	Sentences	Conditions
Bare	Bare	(a) What do you wonder who built ___?	Bare Identity
Bare	Restricted	(b) What do you wonder which engineer built ___?	Inverse Inclusion
Restricted	Bare	(c) Which building do you wonder who built ___?	Inclusion
Restricted	Restricted	(d) Which building do you wonder which engineer built ___?	Complex Identity

The experimental sentences with **Extraction** out of a wh-island were intermixed with 36 corresponding sentences with **No Extraction** for which no retrieval is needed at any moment and thus no interference is predicted to arise:

- Who wonders who built this building?
- Who wonders which engineer built this building?
- Which tourist wonders who built this building?
- Which tourist wonders which engineer built this building?

TASKS: 1. Acceptability judgment on a 7-point Likert scale
2. Eye-tracking study

EYE-TRACKING MEASURES:

- First fixation (FF)**, the duration of the first fixation in each region
- Gaze duration (GD)**, the time spent on each region from the first fixation to the first time leaving it
- Second pass (SP)**, the time spent in a region entering it from the right
- Total duration (TD)**, the total time spent on a given region
- Regressions**, a *n* fixation is a regression if it occurred on a region on the left of the region where the *n-1* fixation occurred. Each regression event was characterized on the basis of origin and destination:
 - Regressions Out**, the region in which the *n-1* fixation occurred
 - Regressions In**, the region in which the *n* fixation occurred

REGIONS OF INTEREST:

What/Which building do you wonder **who/which engineer** built in the Nineties ?

WH1 V1 WH2 V2 SPILLOVER

RESULTS

ACCEPTABILITY JUDGMENT STUDY

EXTRACTION

Main effect of Wh1 ($\beta = 0.38, t = 4.50, p = .006$)

Bare Identity = Inverse Inclusion < Inclusion = Complex Identity

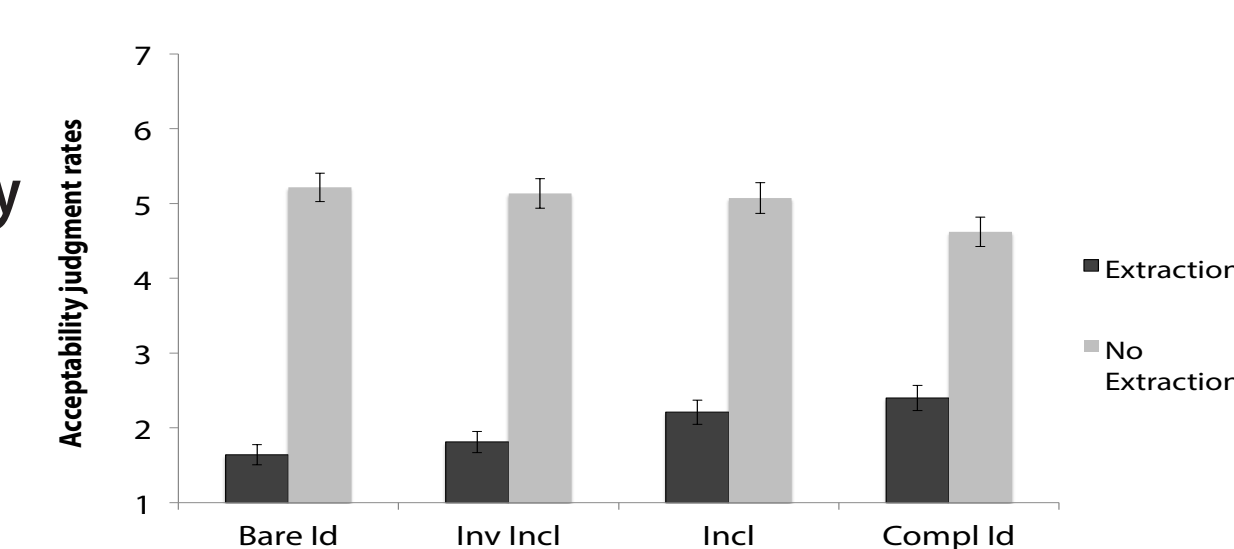
NO EXTRACTION

Main effect of Wh1 ($\beta = -0.164, t = -2.17, p = .052$)

Main effect of Wh2 ($\beta = -0.133, t = -2.56, p = .037$)

Wh1*Wh2 ($\beta = -0.09, t = -2.03, p = .04$)

Bare Identity = Inverse Inclusion = Inclusion > Complex Identity

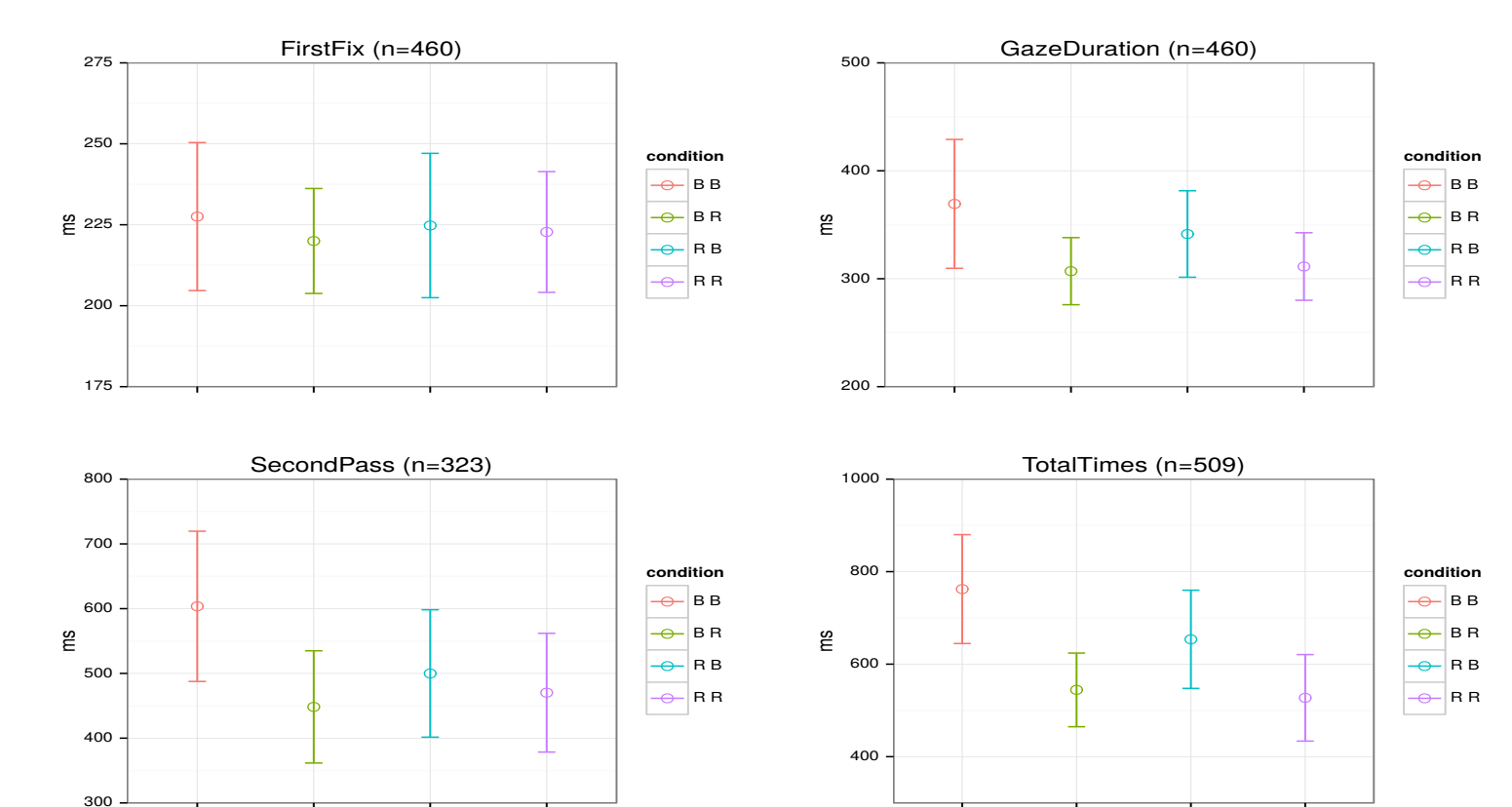


EYE-TRACKING STUDY

EXTRACTION

READING TIMES IN V2

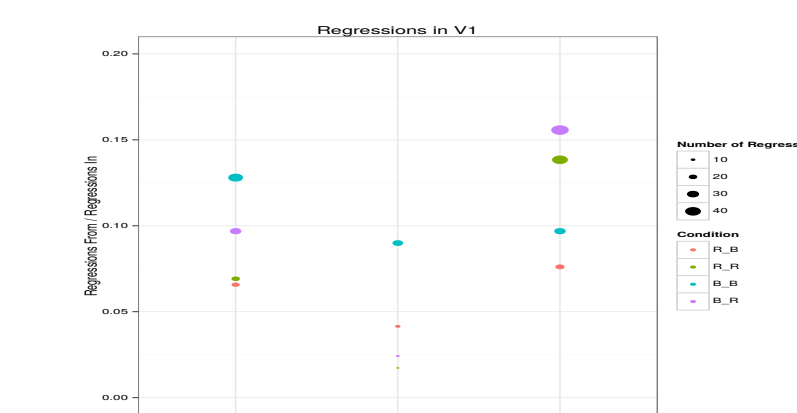
- GD: main effect of Wh2, faster RTs when Wh2 is restricted (-46.71 ms, $t = 2.714, p < .05$)
- SP: main effect of Wh2, faster RTs when Wh2 is restricted (-100.91 ms, $t = 2.28, p < .05$)
- TD: - main effect of Wh2, faster RTs when Wh2 is restricted (-179.08 ms, $t = 4.627, p < .05$);
- main effect of Wh1, faster RTs when Wh1 is restricted (-0.16 logTransformed, $t = 2.6, p < .05$).



REGRESSIONS

Regressions in Wh1: more frequent when Wh1 is restricted than bare (-0.70, $z = -4.780, p < .05$).

Regressions in V1: more frequent when Wh1 is bare (+0.48, $z = 3.698, p < .05$).



Regressions are more frequent in the Extraction ($M = 24.18$) than in the No Extraction condition ($M = 17.94$) ($t(32) = 5.81, p < 0.001$).

NO EXTRACTION

READING TIMES IN V2

- FF: - main effect of Wh1, slower RTs when Wh1=restricted (+16ms, $t = -2.33, p < .05$)
- main effect of Wh2, slower RTs when Wh2=restricted (+0.06 logFixation, $t = -2.22, p < .05$)
- SP: main effect of Wh2, faster RTs when Wh2=restricted (-125.41 ms, $t = 2.78, p < .05$)
- TD: main effect of Wh2, faster RTs when Wh2=restricted (-93.78 ms, $t = 3.34, p < .05$)

CONCLUSIONS

- Structures with No Extraction were rated higher than structures with Extraction, replicating previous findings attesting to a detrimental effect of intervention [5,6].
- Evidence for **encoding vs. retrieval costs** comes from the opposite effect that lexical restriction shows in Extraction and No Extraction conditions, which also replicates previous findings [6]. This result suggests that encoding cost (presumably at play in both the No Extraction and the Extraction conditions) is associated with retrieval ease (presumably at play in the Extraction condition only) [6,7]. More direct evidence for encoding vs. retrieval costs comes from reading times in V2: when no retrieval is needed (i.e. No Extraction condition), the presence of additional syntactic and semantic features carried by lexical restriction makes the encoding harder, without rewarding this additional effort later in the process, leading to slower RTs in early measures (FF); on the contrary, when both encoding and retrieval are needed (i.e. Extraction condition), the presence of additional features eases the retrieval thus speeding up the process which results in faster RTs at V2 in both early and late measures [7].
- However, results for the No Extraction condition also attested to faster RTs for restricted interveners, as Extraction conditions, for later measures following regressions (SP and TD). This may suggest that No Extraction conditions also contain an element of complexity causing regressions (possibly the presence of two wh-elements [8]), which would explain the inversion of the RTs' pattern.
- Regressions analyses for the Extraction conditions provide further evidence for retrieval: restricted Wh1 are associated with more regressions in Wh1, mostly coming from the spillover region, possibly attesting to an attempt of retrieval; conversely, bare Wh1 are associated with more regressions in V1, possibly attesting to a difficulty in retrieving the extracted element when poor information is associated with it.