An ERP study of morphosyntactic processing in first language attrition

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Main premise

- Longstanding debate about “critical period” for L2
  - Maturational constraints on brain plasticity
  - L2 qualitatively different from L1
- Late L2 learners deviate from native speakers in L2 performance (accent, vocabulary, complex grammar)
- Mechanisms underlying L2 processing different than in L1 processing (?)
Main premise (cont.)

BUT:
- Late-learned L2 correlated with low proficiency level / low exposure
- Do L2 learners differ from native speakers in L2 processing
  - *because of the late AGE at which they acquired the L2?*
  - *because of their level of PROFICIENCY or EXPOSURE to L2?*
- Unique group where these factors are **not** confounded:
  - L1 acquired *early* (birth) but **low level of exposure**/proficiency
  - L2 acquired *late* (after CP) but **high level of exposure**/proficiency

→ Profile of minority-language speakers
Minority language speakers

- Immigrated to Montreal **in adulthood**
- Had fully acquired L1 in native country
- Became **immersed in majority L2** (significantly reduced exposure to L1)
- Dominant in L2
- Greater grammatical proficiency, richer vocabulary and greater fluency in L2 than L1

→ **Gradual decline in L1 (= attrition)**
First language attrition

- Various accounts: Loss, decay of representations, problems with access/retrieval, cross-linguistic influence from L2
- Behavioral evidence:
  - Lexical retrieval difficulties, semantic intrusions (L2-L1) (Köpke, 1999; Pavlenko, 2000)
  - Some grammatical difficulties:
    - Word order (Jarvis, 2003), relative-clause formation (Yağmur, 2004), case and plural morphology (Schmitt, 2010), verb agreement (Ben-Rafael, 2004)
- Lexicon more vulnerable than morphosyntax
- But neurocognitive aspects of attrition still relatively unexplored!
Neurocognitive correlates of attrition

- Same processes as **native-speakers** still exposed to L1, despite reduced use?
- Native-like in **dominant L2**, despite late AoA? (➔ proficiency advantage)
- Similar to **late L2 learners** of same proficiency level (or advantage of AoA?)
- How does **L2-to-L1 transfer** modulate online processing patterns?
- **Evidence of attrition in online processing** though not behaviorally? (e.g., some areas of grammar)
- How does it **change** over time? (stages of L2 *acquisition* in reverse?)

➔ Helps complete the picture of L1 and L2 acquisition research!
  - AoA and proficiency operate in different directions
Overview of mega project

- **Linguistic features tested:**
  - Subtle lexical-semantic violations
  - Interlingual homographs and false-friends
  - Regular and irregular Italian past participles
  - Number agreement processing (double violations)
  - Relative clause processing
- **Several ERP reading studies** (all mixed together)
- A range of behavioral (proficiency) measures
- **4 groups** (monolingual AND bilingual controls)
- Tested in both languages
## Overview: Groups

<table>
<thead>
<tr>
<th>Minority-speakers of Italian (L1) + English (L2)</th>
<th>English (L1) native speakers leaning Italian (L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Attriters” / “attrition group”</td>
<td>Bilingual control group</td>
</tr>
<tr>
<td>Born in Italy</td>
<td>Late learners</td>
</tr>
<tr>
<td>Age of immigration &gt; 30 yrs</td>
<td>AOA of Italian &gt; 15 yrs</td>
</tr>
<tr>
<td>AoA English &gt; 15 yrs</td>
<td>High proficiency in L2 Italian</td>
</tr>
<tr>
<td>LoR &gt; 12 yrs</td>
<td></td>
</tr>
<tr>
<td>Limited exposure to L1</td>
<td></td>
</tr>
<tr>
<td>High proficiency in L2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Italian native speakers</th>
<th>English native speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native speaker control group (Italy)</td>
<td>Native speaker control group</td>
</tr>
<tr>
<td>Minimal exposure to other languages</td>
<td>Minimal exposure to other languages</td>
</tr>
</tbody>
</table>
Overview: Range of measures

- **Background questionnaires (language history / use)**
  - Details about AOA, input, exposure/use
  - Social-affective questionnaire (minority group only)

- **Proficiency measures (both languages, also in controls)**
  - Self-rating of proficiency
  - Written C-test
  - Text correction task
  - Verbal fluency task (2 semantic categories)
  - Acceptability judgment during ERP recording (online)

- **Control measures**
  - Reading fluency
  - Working memory
Today’s talk

- BRAND NEW DATA!
- 2 ERP studies in Italian
  - Lexical-semantic anomalies
  - Relative-clause processing
- What do the patterns look like in Italian controls (n = 30)?
- What are preliminary trends in Minority group (n = 8)?
- Are there any behavioral differences between groups so far?
“I have difficulties in finding the right word”

“I feel I’ve lost the subtleties of the grammar”

“My Italian grammar is influenced by English grammar”

“I get my words confused”

“I formulate Italian sentences based on English sentences”

When asked if their proficiency in Italian has declined since immigration, all answered Yes
### Participants: Behavioral measures

<table>
<thead>
<tr>
<th>Behavioral task</th>
<th>Mean (SD) in Minority (n = 8)</th>
<th>Mean (SD) in Italy (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-test (%)</td>
<td>95.6 (4.9)</td>
<td>96.3 (4.4)</td>
</tr>
<tr>
<td>Text correction (%)</td>
<td>85.4 (7.6)</td>
<td>90.0 (5.1)</td>
</tr>
<tr>
<td>Semantic fluency</td>
<td>20.1 (4.6)</td>
<td>23.4 (5.5)</td>
</tr>
<tr>
<td>Working memory (span)</td>
<td>4.9 (0.9)</td>
<td>5.5 (1.1)</td>
</tr>
<tr>
<td>Reading fluency (# correct out of 98 in 3 minutes)</td>
<td>64 (15.9)</td>
<td>71.2 (13.2)</td>
</tr>
</tbody>
</table>

- Do online ERP measures reveal more than what explicit offline proficiency measures tap into?

*These differences are currently not significant with n=8 minority participants*
(1) Lexical-semantic experiment

- 48 pairs of nouns differing only in final vowel, but with different meaning
  - *cappello* vs. *cappella* (*hat* vs. *chapel*)
  - *mento* vs. *menta* (*chin* vs. *mint*)
  - *busto* vs. *busta* (*chest* vs. *envelope*)
- Sentence contexts created for each word (= 96 contexts)
- Different target nouns depending on condition
- 3 conditions:
  - **Correct** (each word in pair occurs in its proper context)
  - **Swap** (two words in pair are switched, *e.g.* *cappello* occurs in *cappella* context)
  - **Mismatch** (word from another pair, *e.g.* *mento* occurs in *cappella* context)
<table>
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<tr>
<th>Correct</th>
<th>Per coprire la testa, il pescatore porta il <strong>cappello</strong> di lana.</th>
</tr>
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<tr>
<td></td>
<td>To cover his head, the fisherman wears the <strong>hat</strong> of wool.</td>
</tr>
<tr>
<td>Swap</td>
<td>Per coprire la testa, il pescatore porta la <strong>cappella</strong> di lana.</td>
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<td>Mismatch</td>
<td>Per coprire la testa, il pescatore porta la <strong>menta</strong> di lana.</td>
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- Balanced design: Each context and target word occurs in each condition
- Distributed across 3 lists (no repetitions for a given subject)
- **Task**: acceptability judgment (rating from 1-5)
Predictions

- Italian controls (native speakers in Italy)
  - Prototypical lexical-semantic N400 for mismatch and swap conditions
  - Followed by P600? (re-analysis, conflict monitoring, Meerendonk, Kolk et al., 2008)

- Italian minority speakers (attriters in Montreal)
  - N400 for mismatch condition
  - Smaller/no N400 for swap condition if words confused and error undetected

*Kutas, Lindamood & Hillyard, 1984*
Acceptability judgment results

![Box plot showing the distribution of acceptability judgments for different conditions. The conditions are labeled as Swap, Mismatch, and Correct. The groups are identified as Italy and Minority.](image-url)
ERP results: Italian control group

Per coprire la testa, il pescatore porta il **cappello** di lana.
Per coprire la testa, il pescatore porta la **menta** di lana.
Per coprire la testa, il pescatore porta il **cappello** di lana.

Per coprire la testa, il pescatore porta la **cappella** di lana.

Per coprire la testa, il pescatore porta la **menta** di lana.
ERP results: Minority group

Per coprire la testa, il pescatore porta il **cappello** di lana.  
Per coprire la testa, il pescatore porta la **menta** di lana.
Per coprire la testa, il pescatore porta il **cappello** di lana.
Per coprire la testa, il pescatore porta la **cappella** di lana.
Per coprire la testa, il pescatore porta la **menta** di lana.
Late positivity in minority group

Minority group: Small N400, Large P600

Control group: Large N400, small late P600
Discussion

- Controls in Italy show early, automatic processing (N400), whereas minority speakers engage in more elaborated/controlled processing (P600; re-analysis).

- This more conscious/metalinguistic judgment might be reflected in behavioral ratings (lower overall ratings in minority group).
(2) Relative clause experiment

- Cross-linguistic differences in Italian vs. English
- 4 word-orders grammatical in Italian, but 2/4 are impossible in English
- Do attriters deviate from Italian controls in how they accept/process word-orders that clash with English grammar?

→ L2-to-L1 transfer (behaviorally and/or online)
<table>
<thead>
<tr>
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<th>Word orders (4 conditions)</th>
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</table>
| 1. V-NP Subject | Il gatto che caccia i topi corre nel giardino.  
S                               O  
(The cat that chases the mice runs in the garden) |
| 2. V-NP Object  | I topi che caccia il gatto tremano di paura.  
O                               S  
(The mice that chases the cat tremble with fear.) |
| 3. NP-V Subject | Il gatto che i topi caccia corre nel giardino.  
S                               O  
(The cat that the mice chases runs in the garden.) |
| 4. NP-V Object  | I topi che il gatto caccia tremano di paura.  
O                               S  
(The mice that the cat chases tremble with fear.) |
Word orders (4 conditions)

<table>
<thead>
<tr>
<th></th>
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<th>Sentence</th>
<th>Sentence Translation</th>
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<td>1.</td>
<td>V-NP</td>
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External ratings suggest #2 and #3 are unpreferred (writing, poetry, low frequency) Di Domenico & Di Matteo (2010) they “are not perceived as less natural, despite low frequency.”
Semantic cues and the Competition Model

- Stimuli push acceptability of unpreferred sentences by creating **strong agent-patient relationships** (e.g., policeman/arrests/thief)
- Competition Model (MacWhinney & Bates, 1989)
  - Cross-linguistic differences in “cue strengths”
    - **Italian**: agreement + semantics (including animacy)
    - **English**: word order (+ agreement)
- Our design encouraged Italians to rely on semantic cues (which should not affect English speakers who rely on word order)
- What about Italians heavily exposed to English???
ERP predictions for unpreferred RCs

- **Italian controls:**
  - If all equally acceptable: No effects (Di Domenico & Di Matteo, 2010)
  - If garden-path effect: P600; if violation effects: LAN + P600
  - If reliance on semantic cues: N400 (MacWhinney & Bates, 1989)

- **Minority speakers:**
  - If influenced by English: Larger morphosyntactic effects (LAN + P600)
  - If less reliance on semantic cues (due to English): small or no N400s
Acceptability judgment results

The figure shows box plots for different conditions: V-NP subj, V-NP obj, NP-V subj, and NP-V obj.

The x-axis represents the conditions, and the y-axis represents the response values.

The groups are color-coded: Italy in blue, and Minority in purple.

The box plots display the median, quartiles, and outliers for each condition.
Il gatto che caccia i topi corre nel giardino.
(The cat that *chases* the mice runs in the garden)
I topi che *caccia* il gatto tremano di paura.
(The mice that *chases* the cat tremble with fear.)
V-NP subject vs. object: Minority group

Il gatto che caccia i topi corre nel giardino.
(The cat that chases the mice runs in the garden)

I topi che caccia il gatto tremano di paura.
(The mice that chases the cat tremble with fear.)
Discussion (1)

- V-NP relative clauses: Group differences for object condition
  - **Controls:**
    - Semantic cues first (N400)
    - Morphosyntactic processing (P600)
  - **Minority:**
    - No reliance on semantic cues (no N400)
    - But stronger morphosyntactic effects (an earlier and larger P600)

→ Transfer from L2-English (support for Competition Model)
Acceptability judgment results

V-NP subj  V-NP obj  NP-V subj  NP-V obj

cond

group
Italy
Minority
NP-V subject vs. object

I topi che il gatto caccia tremano di paura.
(The mice that the cat chases tremble with fear.)

Il gatto che i topi caccia corre nel giardino.
(The cat that the mice chases runs in the garden)
NP-V subject vs. object

Controls

Il gatto che i topi **caccia** corre nel giardino.
*(The cat that the mice **chases** runs in the garden)*

I topi che il gatto **caccia** tremano di paura.
*(The mice that the cat **chases** tremble with fear.)*

Minority
• NP-V relative clauses: Group differences for subject condition
  ○ **Controls**
    ✷ Early frontal positivity (no LAN) – weak garden path effect
      *(see Mecklinger et al. on garden path effects in German relative clauses)*
  ○ **Minority**
    ✷ Early negativity (LAN) – perceived as a violation (as in English)

→ Preliminary results in line with idea that **English dominance has effect on how attriters process (and accept) relative clauses**
Take home message

- Evidence of **ongoing brain plasticity for L1 + L2**

- **Environment/L2-induced changes in L1 processing**, even if L2 becomes dominant late in life

- Changes in both **lexical-semantics** and **morphosyntax**
More participants in minority-group
Comparison with advanced L2 learners of Italian
Individual differences in ERP patterns and acceptability ratings
Behavioral variables predicting ERPs?
  - LoR
  - Working memory
  - Proficiency measures
  - Attitudes/motivation, etc
English studies with same bilingual subjects
  - Compared to English native speakers
Thank you!

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Questions? Suggestions?
Acknowledgments

- **Funding:**
  - (K. Kasparian)
  - Vanier Canada Graduate Scholarship
  - Richard H. Tomlinson Fellowship
  - Michael-Smith Foreign Study Supplement
  - (K. Steinhauer)
  - Canada Research Chair Program
  - NSERC Discovery grant

- **Supervision:**
  - Dr. Karsten Steinhauer
  - Dr. Francesco Vespignani

- **Valuable feedback:**
  - Dr. John Drury
  - Dr. Eleonora Rossi
  - Dr. Monika Schmid
  - Dr. Phaedra Royle

- **Research assistants:** Paolo Zandomeneghi, Filippo Vicari, Linna Jin