The case of a non-native-like first language:

ERP evidence of first-language attrition in the brain

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Background

- Neurobiological ‘critical period’ for language-learning is still controversial

- **Claim:** Maturational constraints on brain plasticity
  - L1 is “hard-wired” and stable from early years of life
  - L2 must rely on “non-native-like” processing mechanisms

- **However,** increasing evidence of neural plasticity (even in adulthood) has cast doubt on claim
A confound with age

- A number of studies have shown that “late-learners” differ from native-speakers in neurocognitive processes in L2.
- However, **late age-of-acquisition** (AoA) often confounded with **low proficiency level** (and low exposure).

→ Differences in brain because L2 was learned LATE or because speakers are not fully proficient in L2?

- **Immigrants immersed in a new language in adulthood**
  - Highly-proficient in late-acquired L2
  - Low exposure and “attrition” (= decline) in native-L1
Aims

(1) To tease apart age-effects from proficiency-effects in both L1 and L2 processing in the brain

- Are ‘attriters’ still native-like and stable in L1, due to early AoA?
- Do late L2-learners differ from native-speakers, due to late AoA?
- Does proficiency modulate processing patterns, regardless of whether the language was learned as L1 or L2?
Aims

(2) To study the neural correlates of L1 attrition which are still relatively unexplored

- Is there evidence of attrition in online L1-comprehension?
“Attriters”

- Italian native speakers (born in Italy)
- Immigrated to Montreal in adulthood
- Had fully acquired standard-Italian
- Dominant in English (limited use of Italian)
- All of them report changes to Italian, for example:
  - Confusing words and trouble finding words in Italian
  - Italian grammar influenced by English grammar
Groups

- “Attriters” (first generation immigrants; $n = 24$)
  - Italian (non-dominant L1) + English (late, high-proficient L2)
- Late L2-learners ($n = 20$)
  - English (L1) + Italian (late, highly proficient L2)
- Italian native-speakers in Italy ($n = 30$)
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Experiment 1

Lexical (vocabulary) access in online comprehension of Italian
Research questions

- Evidence to support anecdotal reports of “confusing words”?
- Is automatic detection of lexical-semantic violations modulated by proficiency, both in L1-attributers + L2-learners?
Design

- Sentences where target words are “confusable nouns”: Minimal-pairs differing only in final vowel, but also meaning
  
  *cappello* (hat) vs. *cappella* (chapel)
  *
  *mento* (chin) vs. *menta* (mint)

- Reading study
- Task: Acceptability judgment (rating 1-5)
| Design       |  |  |
|--------------|  |  |
| **Correct**  |  | Per coprire la testa, il pescatore porta il *cappello* di lana.  
| (each word in |  | *To cover his head, the fisherman wears the hat of wool.*  |
| pair occurs in|  |  |
| proper context) |  |  |
| **Swap**     |  | Per coprire la testa, il pescatore porta la *cappella* di lana.  
| (words in pair |  | *To cover his head, the fisherman wears the chapel of wool.*  |
| are switched) |  |  |
| **Mismatch** |  | Per coprire la testa, il pescatore porta la *menta* di lana.  
| (word from a |  | *To cover his head, the fisherman wears the mint of wool.*  |
| different pair) |  |  |
Predictions

- **Italian native-speakers**
  - Classic **N400** for ‘mismatch’ and ‘swap’
  - Followed by small **P600**? (⇒ re-analysis/monitoring)
Predictions

- **Italian native-speakers**
  - Classic N400 for ‘mismatch’ and ‘swap’
  - Followed by small P600? (→ re-analysis/monitoring)

- **Attriters / late L2-learners**
  - If words are confused, ‘swap’ violation may go undetected
    - N400 only for ‘mismatch’ condition
    - Smaller/no N400 for ‘swap’ condition
  - Followed by large P600? “second thought”, more monitoring
Predictions

- **Modulated by proficiency?**
  - Lower Italian proficiency → less native-like ERP patterns
  - Within each proficiency level (H or L), no group differences
    - HP attriters = HP L2 learners = Native-controls
    - LP attriters = LP L2 learners ≠ Native-controls

- **Evidence for a “critical period” (L1 ≠ L2)?**
  - Attriters = Italian native-controls ≠ Late L2-learners
Mismatch: To cover his head, the fisherman wears the mint of wool.
Swap: To cover his head, the fisherman wears the chapel of wool.
Correct: To cover his head, the fisherman wears the hat of wool.
High proficiency groups

In N400 window: HP attriters = HP L2 learners = Native-controls
Low proficiency L1 attriters and L2 learners

**L1 attriters**
- N400 mismatch only
- P600

**L2 learners**
- N400 mismatch only

In N400: LP attriters = LP L2 learners ≠ Native-controls
N400 is modulated by proficiency

- Controls, high proficiency attriters and high proficiency L2 learners show **significant N400 for both violations**

- Low proficiency attriters and low proficiency L2 learners **do not automatically detect ‘swap’** (no significant N400)

- Significant correlations between various Italian proficiency measures and the amplitude of the N400

→ **N400 effects were mediated by proficiency in both bilingual groups, regardless of AoA (L1 vs. L2)**
A closer look at the P600

- **Proficiency effect:**
  - High proficiency groups show significant P600
  - Significant correlations between proficiency and P600 amplitude

- **However, group membership (L1 vs. L2) does impact P600**
  - Controls: Small but highly significant P600
  - Attriters: Large P600
  - L2 learners: No P600

→ Larger P600 effects in attriters may reflect **elaborated processing** (explicit ‘second thought’, increased monitoring)
Discussion

- First ERP evidence of ‘non-native-like’ online lexical-semantic processing in attriters, particularly for:
  - Speakers with lower L1 proficiency (i.e., more attrition)
  - Confusable words (‘swap’ condition)

→ This finding favors the view of ongoing neuroplasticity in adulthood even in one’s L1
Experiment 2

Morphosyntactic (grammar) processing in online comprehension of Italian
Research questions

- Is there evidence of attrition in morphosyntax (although studies suggest grammar less vulnerable)?
- Do attriters interpret and process Italian differently than native controls due to transfer from English?
Design

- **Relative clauses: Cross-linguistic differences**
  - In **grammaticality**
    - 4 word orders are possible in Italian
    - 2/4 are ungrammatical in English
  - In **cues** speakers use to interpret sentences*
    - Italian speakers rely on semantic cues (word-order flexible)
    - English speakers rely on word-order
  - Strong agent-patient relationships (e.g. policeman/arrests/thief)
  - Task: Acceptability judgment (1-5)

*Competition Model (MacWhinney & Bates, 1989)
<table>
<thead>
<tr>
<th></th>
<th>V-NP</th>
<th>Subject/Object</th>
<th>Stimuli</th>
<th>Corrected Sentence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>V-NP</td>
<td>Subject</td>
<td><em>Il gatto che caccia i topi corre nel giardino.</em></td>
<td>(The cat that chases the mice runs in the garden)</td>
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<td><em>S O</em></td>
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<tr>
<td>2</td>
<td>V-NP</td>
<td>Object</td>
<td><em>I topi che caccia il gatto tremano di paura.</em></td>
<td>(The mice that chases the cat tremble with fear.)</td>
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<td><em>O S</em></td>
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<tr>
<td>3</td>
<td>NP-V</td>
<td>Subject</td>
<td><em>Il gatto che i topi caccia corre nel giardino.</em></td>
<td>(The cat that the mice chases runs in the garden.)</td>
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<td><em>S O</em></td>
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<td><em>O S</em></td>
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</tr>
</tbody>
</table>
### Stimuli

| 1. V-NP subject | Il gatto che caccia i topi corre nel giardino.  
|                 | (The cat that chases the mice runs in the garden) |
| 2. V-NP object  | I topi che caccia il gatto tremano di paura.  
|                 | (The mice that chases the cat tremble with fear.) |
| 3. NP-V subject | Il gatto che i topi caccia corre nel giardino.  
|                 | (The cat that the mice chases runs in the garden.) |
| 4. NP-V object  | I topi che il gatto caccia tremano di paura.  
|                 | (The mice that the cat chases tremble with fear.) |
Predictions

- Italian native-speakers
  - Reliance on semantic cues $\rightarrow$ N400
  - Mild garden-path effects? All conditions are grammatical, but #2-3 are preferred
Predictions

- **Italian native-speakers**
  - Reliance on semantic cues → N400
  - Mild garden-path effects? All conditions are grammatical, but #2-3 are unpreferred

- **Attriters**
  - If following Italian grammar → same patterns as controls
  - If transfer from L2-English grammar → little/no reliance on semantic cues (no N400) and #2-3 should be perceived as strong grammatical violations (LAN and/or P600)
Online acceptability ratings
Online acceptability ratings
V-NP subject vs. object: Italian natives

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: Attriters

No N400: No evidence of reliance on semantic cues. Stronger grammatical violation effect (larger P600)
Online acceptability ratings

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

Controls  Attriters
NP-V subject vs. object: Italian natives

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.)

→ Mild garden-path effect, rather than outright grammatical violation
NP-V subject vs. object: Attriters

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)

Different pattern: Early negativity instead of early positivity
Subject vs. Object

**CONTROLS**
- P3a: 0.300 .. 0.450 s
- P600: 0.450 .. 0.700 s

**ATTRITERS**
- N400: 0.300 .. 0.450 s
- LAN?: 0.450 .. 0.700 s
- P600: 0.700 .. 1.000 s
Baseline problem (in attriters)?
Baseline problem?

Baseline from 0 – 200ms more appropriate given early differences driven by previous word. However, instead of a large negativity, attracters now show a large P600 (larger than controls).
Discussion

- Results for V-NP are more straightforward than NP-V sentences, especially for attriters. However, regardless of baseline, attriters differ from controls in processing patterns.

- For word orders that are ungrammatical in English (but possible in Italian), attriters give lower ratings AND process sentences as grammatical violations when reading in Italian.

→ **L2-dominance affects grammar in the native L1**

- Currently investigating proficiency effects (as in Exp.1)
Conclusions

- First ERP evidence of L1-attrition (vocabulary + grammar)
- Proficiency impacts processing patterns in L1 and L2
- Evidence of ongoing brain plasticity, even in adulthood
- The “downside” of brain plasticity – L1 is not stable
THANK YOU!
Acknowledgements

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

- **Supervision:**
  - Dr. Karsten Steinhauer (McGill)
  - Dr. Francesco Vespignani (Uni Trento)

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

- **Research assistants:** Kristina Maiorino, Paolo Zandomeneghi, Filippo Vicari, Lucia D’Arienzo, Linna Jin