Effects of L1 background and L2 proficiency on L2 sentence processing: An ERP study

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Aims

- **Neurocognitive mechanisms** underlying real-time sentence processing in **adult second language (L2) learners**

- Effect of **first language (L1) background** on L2
  - Transfer/interference between grammars

- Influence of **proficiency level** on:
  - L2 processing
  - Degree of interference from L1
Second language (L2) processing

- **Main question in this line of L2 research:**
  - How “native-like” are processing mechanisms and neural substrates for L2 vs. L1?

- L2 acquisition “fundamentally different” from L1 acquisition
- Different factors at play in L2 learning
Second language (L2) processing

- **Age of acquisition (AOA)**
  - Critical Period for language learning (Lenneberg, 1967)
  - Different language processes and brain areas for L2 vs. L1 (Kim et al., 1997, Weber-Fox & Neville, 1996)

- **Proficiency level**
  - Affects brain organization & patterns of language processing (Perani et al., 1998; Steinhauer et al., 2009)

- **Crosslinguistic transfer**
  - L1 knowledge may affect L2 learning/processing
Two views of crosslinguistic transfer

- **Influence of L1 in L2 acquisition**
  - Depends on similarities or differences between L1 & L2
    - **Positive transfer** – when L1 and L2 have similar properties
      → facilitation in learning
    - **Negative transfer** – when L1 and L2 are contradictory
      → interference/difficulty in learning

- **Co-activation of L1 during L2 processing**
  - Automatic
  - When L1 and L2 properties differ → interference
  - Co-activation does not *necessarily* impact L2 acquisition
  - But *may* lead to more persistent transfer if not inhibited
Using ERPs to study transfer effects

- Long history of **behavioral studies** on L1-L2 transfer (Nitschke et al., 2009 for a review; but see Clahsen & Felser, 2006)

- **ERP evidence of transfer** is limited and inconclusive (Kotz, 2009 for a review)

- **Excellent temporal resolution** (in milliseconds)
  - Useful method to study language comprehension
  - Timing of language-related cognitive processes as they unfold
Eliciting ERP responses

- **Violation paradigm:**
  - Test sentences contain violation occurring on specific target word
  - Directly contrasted with correct (control) sentences
  - Analyze difference in brain waves between these 2 conditions

  e.g.  
  - *The soup has been eaten by the man* *(lexical-semantic/meaning violation)*
  - *The soup has been killed by the man* *(lexical-semantic/meaning violation)*
  - *The soup has been eat by the man* *(grammatical violation)*

- Specific language processes trigger **identifiable wave patterns**
  - Differ in **timing** and **location on scalp**
Lexical-semantic (meaning) processing

- The pizza was too hot to ...
  *cry vs. eat

- N400
  - Negative wave
  - ~ 400 ms after violation
  → Marker of difficulty in word meaning integration

Kutas, Lindamood & Hillyard, 1984
Syntactic (grammar) processing

- **The children...**
  - *plays* vs. *play* in the garden

- **P600**
  - Positive wave
  - ~ 600 ms after violation
  - Controlled grammatical processing, reanalysis and repair

*Weber-Fox & Neville, 1996*
Some kinds of grammatical violations elicit a **biphasic pattern** of N400 + P600

- **N400**: Search/retrieval of lexical-semantic properties of word + clash
- **P600**: Failed integration

*(Pattern we expect to see in our own study)*

*NP* (ACC) + intransitive verb

*Peter met Mary*

*Peter yawned Mary*

Argument structure violations: Wrong *number* of arguments

(Friederici & Frisch, 2000)
ERP evidence of transfer

- Thierry & Wu (2007)
  - Lexical transfer effects
  - Native-Mandarin learners of English
  - Pairs of English words (semantic relatedness task)
  - For half the pairs, the words shared a character in Mandarin
    e.g. *Train* and *Ham* → *Huo Che* and *Huo Tui*
  - Subjects’ brain responses showed an implicit character repetition priming effect (reduced N400 effect)

- **Automatic L1 lexical activation during L2 reading**
  - Effect not seen in behavioral performance; only ERPs!

Could these findings be replicated in domain of **syntax**?
Our present study

- Syntactic transfer
- ERP reading study in English
- 2 groups of **late L2 learners** of English
  - Native-French
  - Native-Mandarin
- Compared to **native English monolinguals**
Conditions

- Adjective-noun word order
- Violation paradigm designed to introduce online conflict between L1 and L2
  - English and Mandarin – adjectives are pre-nominal
  - French – majority of adjectives are post-nominal

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<th>Mandarin</th>
<th>French</th>
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<td>i)</td>
<td>...the white vase...</td>
<td>✓</td>
<td>× ...le blanc vase</td>
</tr>
<tr>
<td>ii)</td>
<td>...the vase white...</td>
<td>×</td>
<td>✓ ...le vase blanc</td>
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<tr>
<td>iii)</td>
<td>...the big vase...</td>
<td>✓</td>
<td>✓ ...le grand vase</td>
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<tr>
<td>iv)</td>
<td>...the vase big...</td>
<td>×</td>
<td>× ...le vase grand</td>
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Research questions

- **Native English speakers:**
  - Adjective order violations $\rightarrow$ N400 followed by P600

- **Adult L2 learners of English** (vs. native English speakers)
  - AOA-effects? (support for “critical period”?)
    - Delayed, smaller or missing N400/P600 effects?
    - Different scalp distributions?
  - **Proficiency effects?**
    - High proficiency speakers = “native-like” ERP patterns
  - **Transfer (L1 background) effects?**
    - Differences in French-L1 vs. Mandarin-L1
Transfer effects: Predictions

- No interference for Mandarin-L1 and comparable effects for both violation conditions (same as English)
- Negative transfer/interference only for French-L1 in i vs. ii
- Comparison of English control conditions (i vs. iii) could also be informative, as correct control (i) = L1-violation in French

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<td>✗</td>
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Participants

- **Initial sample**
  - English-L1 (n = 13)
  - French-L1 (n = 11)
  - Mandarin-L1 (n = 12)

- **Language background questionnaire**
  - Age of acquisition (AOA) of English
  - Exposure to each language

- **Proficiency measures**
  - *Global L2 proficiency*:
    - Self-ratings
    - Cloze-test
  - *Specific knowledge of adjective word order*:
    - Online grammaticality judgments (behavioral)
    - Structure-specific proficiency
Procedure

Silent reading of correct/incorrect English sentences

Examples of stimuli

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<td>i.</td>
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<tr>
<td>ii.</td>
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<td>iv.</td>
<td>L1-L2 violation</td>
<td>He put the vase big</td>
<td>on the table</td>
</tr>
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Baseline

- End-of-sentence grammaticality judgments
- Intermixed with 8 types of filler sentences (1/2 violations)
- Rapid serial visual presentation (300ms, 200ms ISI)
Initial sample: Behavioral results

- % acceptability
- All groups were highly accurate in grammaticality judgments
- But L2 groups rejected violations less accurately than English natives
- However, L2 groups did not differ from each other
Initial sample: ERP results

- **English native speakers:**
  - **N400:** difficulty in lexical-semantic integration
  - **P600:** difficulty in grammatical processing; reanalysis

He put the...
Initial sample: ERP results

- **Mandarin-L1 speakers:**

- **Same ERP patterns as English native speakers**
Initial sample: ERP results

- **French-L1 speakers:** *Pre-nominal* adjective condition
  - No transfer/interference expected
  - Pre-nominal in both French (L1) and English (L2)  
    e.g. “*big vase*” – “*grand vase*”

- Same ERP patterns as English-L1 and Mandarin-L1 speakers
Initial sample: ERP results

- **French-L1 speakers:** *Post-nominal adjective condition*
  - Negative transfer (interference) expected
  - Post-nominal in French but pre-nominal in English
  - e.g. “white vase” but “vase blanc”

- Different L2 pattern: N400 only??
French-L1 speakers (cont).

- Earlier effects for correct control condition!

- Effect triggered by adjective (too early to be tied to L2)

- **L1 violation effect:** English control is ungrammatical in French

- **L2-effects:**
  - Missing L2-P600?
  - Is large L2-N400 a real L2 effect or continuation of positivity?
French-L1 speakers (cont).

- Aim: Correct for early difference and see if L2-N400 survives
- New baseline: 700-800 ms

- L2-violation: English native-like pattern! (N400+P600)
Initial sample: Discussion

- No significant ERP differences between English, Mandarin and French participants when L1 and L2 converge.

- L1 causes clash in French speakers for adjectives that are pre-nominal in English (= post-nominal in French).
  - “The white vase” vs. “le vase blanc” - short lived “L1-P600”

- L1-activation is transient: Does not hinder L2 processing.
  - French-L1 speakers showed native-like L2 processing pattern (N400 + P600) after baseline correction.
Follow-up with larger sample

- **Larger sample:**
  - English (n = 17)
  - Mandarin (n = 21)
  - French (n = 23)

- **Behavioral results:**
  - High accuracy in acceptability judgments
  - No difference between L2 groups
  - No evidence of transfer effects

- **ERP results:**
  - Similar ERPs (N400+P600) for English-L1 & Mandarin-L1
Focusing on the French-L1 group...

All four conditions

No additional baseline correction necessary to see L2 effects
Focusing on "the white vase"...

= Good in ENG, Bad in FR

English
Mandarin
French

N400 (French viol.)
P600 (French viol.)
Larger sample: Discussion

- **Similar ERP signatures of L2 processing**: N400 + P600
  - **Across groups**: English, Mandarin, French
  - Against strong version of “critical period” claim that L2 processing is qualitatively different

- **Transfer effect** in French-L1 group where L1 & L2 differ
  - L1 grammar is activated while processing L2
    - L1-driven N400 + P600
  - Only in the group we expect + in condition we expect!
  - Overridden by L2 grammar processing

- Similar findings as Thierry & Wu (2007) but for syntax
  - Automatic L1 activation during L2 processing
  - Not evident in behavioral results
Proficiency-level in L2 (English)

- Currently investigating whether L1 transfer effects mediated by L2 proficiency level
- Is there more to it than co-activation of L1 that does not affect L2?
- In low proficiency speakers, this co-activation might lead to transfer in its “classical view” (difficulties in L2 due to L1 grammar)

**Low proficiency level → more persistent L1 interference?**

**→ less native-like L2 processing?**

- Which measure of proficiency best predicts ERP patterns?
  - Global proficiency vs. Structure-specific proficiency
French-L1 group: High vs. Low proficiency

- **By cloze test:** no real differences in L1 effects
French-L1 group: High vs. Low proficiency

- **Behavioral accuracy:** larger L1-P600 in low proficiency
Proficiency effects: Preliminary findings

- Initial evidence that proficiency level mediates transfer effects in French L2-learners
  - L1-P600 (“transfer”) effect limited to low-proficiency French group
- Currently testing additional low-proficiency French-L1 speakers
- Our prediction (based on other L2 data from our lab):
  - Including more low proficiency French speakers
    - Stronger transfer effects (L1-P600 will be even larger)
    - Weaker L2 effects (L2-P600 smaller than in current sample)
Take home message

- **ERP data** on transfer effects in *grammar*
- **L1 grammar** plays a role in L2 processing/acquisition
  - Even for structures that are rather easily learnable
  - Even if not particularly useful (different properties)
- May *interfere* down the line with *native-like L2 processing*, especially at *low proficiency* level
- **Highlights interplay between factors** such as AOA, L1 background and proficiency level in L2 learning/processing
- Demonstrates ERPs extremely useful at detecting differences in processing patterns *in absence of behavioral differences*
THANK YOU!
Acknowledgments

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- University of Montreal: *Bursary of Excellence to NB*
EXTRA INFORMATION
## Initial Sample

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Larger sample (incl. initial)

- Behavioral results:

  - English-L1 = 17, French-L1 = 23, Mandarin = 21
Larger sample: English

- English (n = 17)
- All four conditions

- Control conditions only
  No differences
Larger sample: Mandarin

- Mandarin (n = 21)
- All four conditions

- Control conditions only
  No differences
Predictions: Native English

- Adjective order violations → Posterior positive-going **P600**
  - Non-canonical adjective orders:
    - e.g. *brown big dog vs. big brown dog*
    - (Kemmerer et al., 2006)

2 possible ERP patterns: What precedes the P600?

- Biphasic (E)LAN + P600?
  - Syntactic ERP profile
  - Syntactic word-order violation
    - (Neville et al., 1991)
Predictions: Native English (cont.)

OR:

- Biphasic N400 + P600 pattern?
  - Secondary predication
  - He painted the vase white
  - Depends on lexical properties of verb
  - He saw the vase white
  - N400: Search/retrieval of lexical-semantic properties + clash
  - P600: Failed integration

*NP_{ACC} + intransitive verb

Peter met Mary
*Peter yawned Mary

Argument structure violations: Wrong number of arguments

(Friederici & Frisch, 2000)
Structure-specific vs. general proficiency

- Further evidence from another condition in same study

- Native-French (N=23) and native-Mandarin (N=21) late learners of English were compared to native-English monolinguals (N=17) in a reading ERP study in English
- Nominal morphology: articles and their interaction with singular/plural markers [7, 8]
- English and French make use of nominal morphology [cf. Table 1]
- Mandarin: no singular indefinite determiner and no singular/plural morphology [4]
- Target sentences contained NPs involving mismatching plural morphology and singular indefinite articles

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Fig 1: Acceptance rates

- COR
- VIOL

Fig 2: English-L1

Fig 3: Voltage maps

Fig 4: French-L1

Fig 5: Mandarin-L1

- As predicted for the native-English, the mismatch violation condition ("a books") elicited a left anterior negativity (LAN, 350-450ms) + P600 (cf. Fig.2)
- In contrast, an N400+P600 pattern + a subsequent anterior negativity was found in the French-L1 and Mandarin-L1 groups (cf. Fig 4 and 5)
• No differences between French and Mandarin learners at either low or high proficiency levels.

• High proficiency groups (Fig 6a): marginally significant posterior negativity followed by large P600 ($p < .0001$). No late negativities.

• Low proficiency groups (Fig 6b): broad N400 (cond $p < .04$), weak P600 at Pz only, and late anterior negativity (1200-1300 ms; cond*antpost: $p < .02$).

• Irrespective of L1-background, the P600 amplitude significantly correlated with L2 proficiency, and more so in terms of structure-specific proficiency (behavioral error rates, $r = -0.51$, $p < 0.05$) than overall proficiency (cloze test, $r = 0.32$, $p = 0.05$) or age of acquisition ($r = -0.45$, $p < 0.05$).

• In a stepwise regression, only the behavioral error rates (acceptability for incorrect sentences) survives as a significant predictor of size of P600 effect.
Syntactic transfer effects

- **Tokowicz & MacWhinney (2005)**
  - Native-English (L1) learners of Spanish (L2)
  - Grammaticality judgment task:
    - Tense-marking (L1 similar to L2)
    - Determiner-number agreement (L1 differs from L2)
    - Determiner-gender agreement (unique to L2)
  - Sensitive to L2 grammatical violations (P600 effect) *only* on constructions similar in L1-L2 or unique to L2
  - Violations in L2 *not* detected when L1 and L2 dissimilar

- L1 background affects L2 grammatical processing
  - No indication of this distinction in behavioral performance