Differential ERPs to local vs. global prediction failures

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Background

- ERPs show that language comprehension is supported by **predictive** mechanisms
  - E.g., "*The day was breezy so the boy went outside to fly __an airplane__/__a kite__*" shows N400 effects on the unexpected vs. expected article (*an* vs. *a*) before the content noun was heard (Delong et al., 2005, *Nat. Nsci.*)
- Previous research has not directly distinguished between predictions about *what* element is expected to occur, and *when* that element is expected to occur
- We examine prediction effects using **Italian articles**, which may trigger either *local* or *global* mismatches with a predicted noun

Italian article-noun agreement

- Articles agree with noun in gender
- For each gender there are two allomorphs, conditioned by the phonology of the next word
- *Masculine*
  - Default: *un incidente*
  - Before complex onset: *uno scrittore*
- *Feminine*
  - Default: *una bomba*
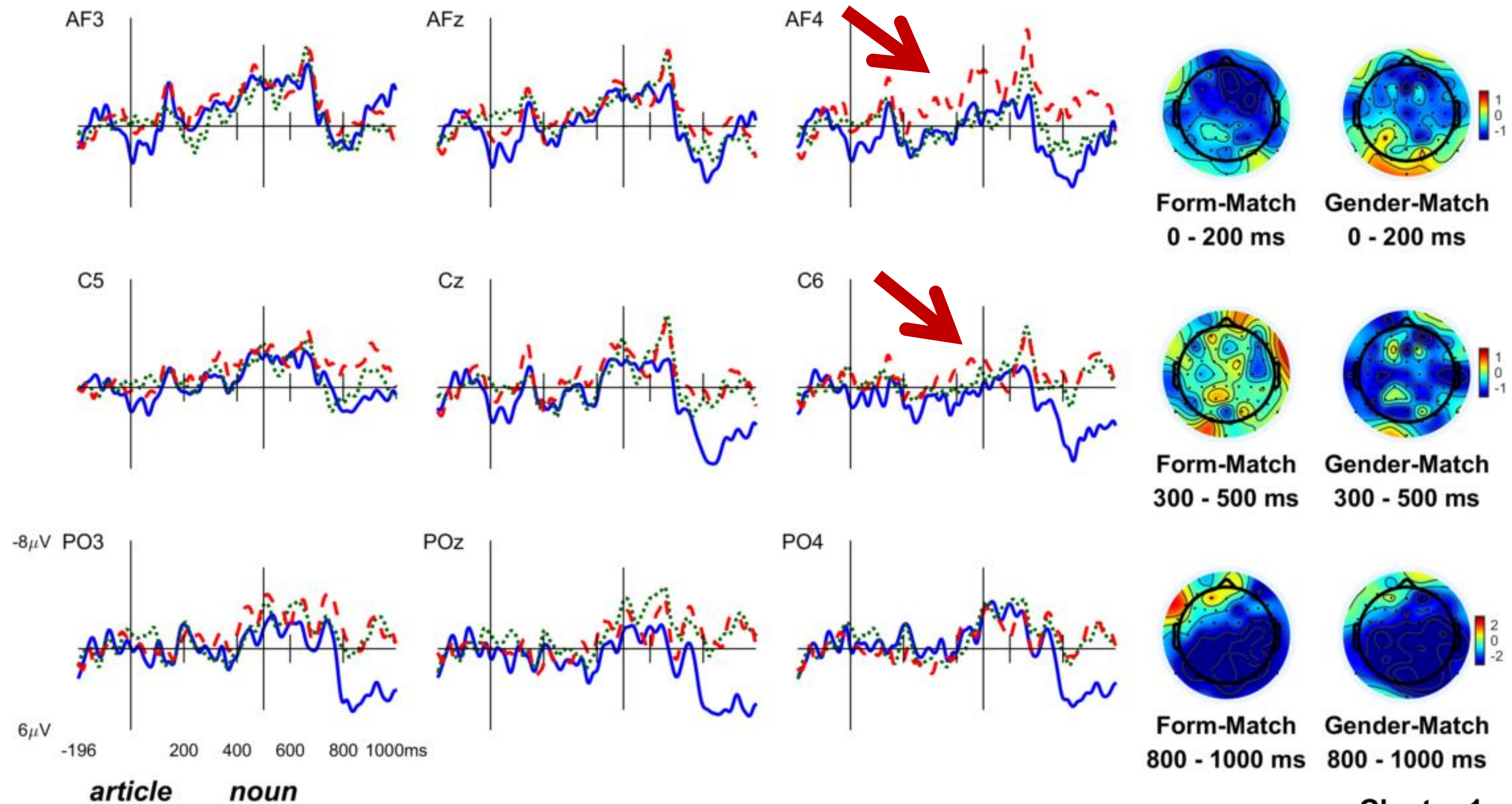 - Before vowel: *un'arca*

Design

- 36 sentences with a strong prediction (cloze >40%) for the final noun
- The article (and following noun) either **matched** the predicted noun, or mismatched it in **form** or **gender**

- *Il rischio maggiore è che dei batteri entrino nella ferita e provochino...*

  The major risk was that bacteria would enter the wound and cause…

un'[f] infezione[f]	una[f] bomba[f]	uno[m] sport[m]
an infection	a bomb	a sport
MATCH	FORM-MISM.	GENDER-MISM.

- Form-mismatch triggers a *local* prediction failure, as the expected noun might still appear later (compare: *an airplane* vs. *a big airplane*)
- Gender mismatch triggers a *global* prediction failure, as the expected noun will not appear

Results (*N* = 23 native Italian speakers [6 more excluded]; 36 items, serial visual presentation)

Discussion

- **Nouns** inconsistent with prediction elicited robust N400s, as expected
- **Articles** showed some negative-going trends before the appearance of the noun

- **Local prediction failure** (**form mismatch**): early (<100ms) negativity; not predicted but possibly meaningful (see Dikker et al., 2009, *Cognition*); this negativity ended quickly

- **Global prediction failure** (**gender mismatch**): same early negativity (numerically weaker), followed by a negative effect extending into the N400 time window and unique to gender mismatch

- Both effects weak and showing non-canonical topography, but note that the study had low power (est. 12%, from 1000 simulations) to observe prototypical effects

- Pending replication, **the data suggest that the neural response to prediction failures is sensitive to the recoverability of the failure:** local prediction failures may trigger transient disruptions whereas global failures may trigger longer-lasting effects.

N400 time window (300-500 ms) on *articles* showed a [non-significant] negativity **gender mismatch** (cluster-based permutation *p* = .132) and no comparable effect for **form mismatch** (*p*s > .429). The cluster extent of the gender-mismatch negativity is shown to the right.