Individual differences in logical ability predict ERP responses to underinformative sentences

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4th Neurobiology of Language Conference (2012)

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Introduction: Scalar Inference

Some of has both semantic and pragmatic readings:

1) "Some of the students are hard-working."
   → *Some of* semantically means "**at least one**", but implies "**not all**" by a process of *pragmatic enrichment*

Sometimes the ***some of*="not all"** pragmatic enrichment is infelicitous:

2) # "Some of the elephants in the zoo have trunks."

In contexts like (2), processing quantifiers may involve rapid realization and then effortful revision/inhibition of the scalar inference (Politzer-Ahles et al., in press).

Does the comprehender's pragmatic sensitivity or logical ability modulate scalar inference processing?

- (see e.g. Dieussaert et al., 2011, [on working memory] and Nieuwland et al., 2010 [on pragmatic ability])

## Present Study: Design

EEG stimuli

Consistent   Pragmatically inconsistent
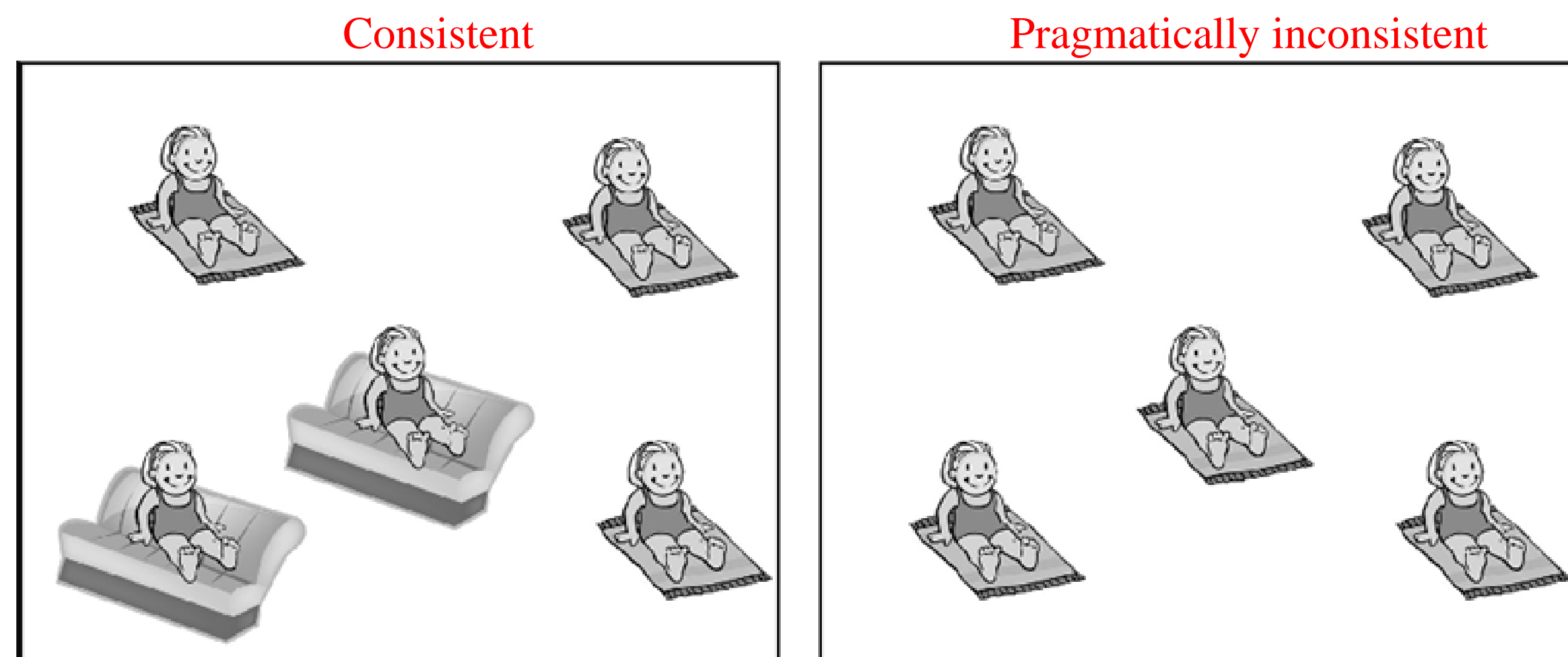
图片里，有的女孩坐在毯子上晒太阳。
In the picture, some of the girls are sitting on blankets suntanning.

Offline rating task with underinformative sentences:

- # "Some turtles have shells."
- # "Some sentences have words."

- **Truth ratings** and **naturalness ratings** on 1-7 scales
  - Truth rating ≥ 4 → good at realizing semantic meaning
  - Truth rating < 4 → poor at realizing semantic meaning

Distribution of responses in truth/naturalness rating task


- Good logical ability
- Poor logical ability
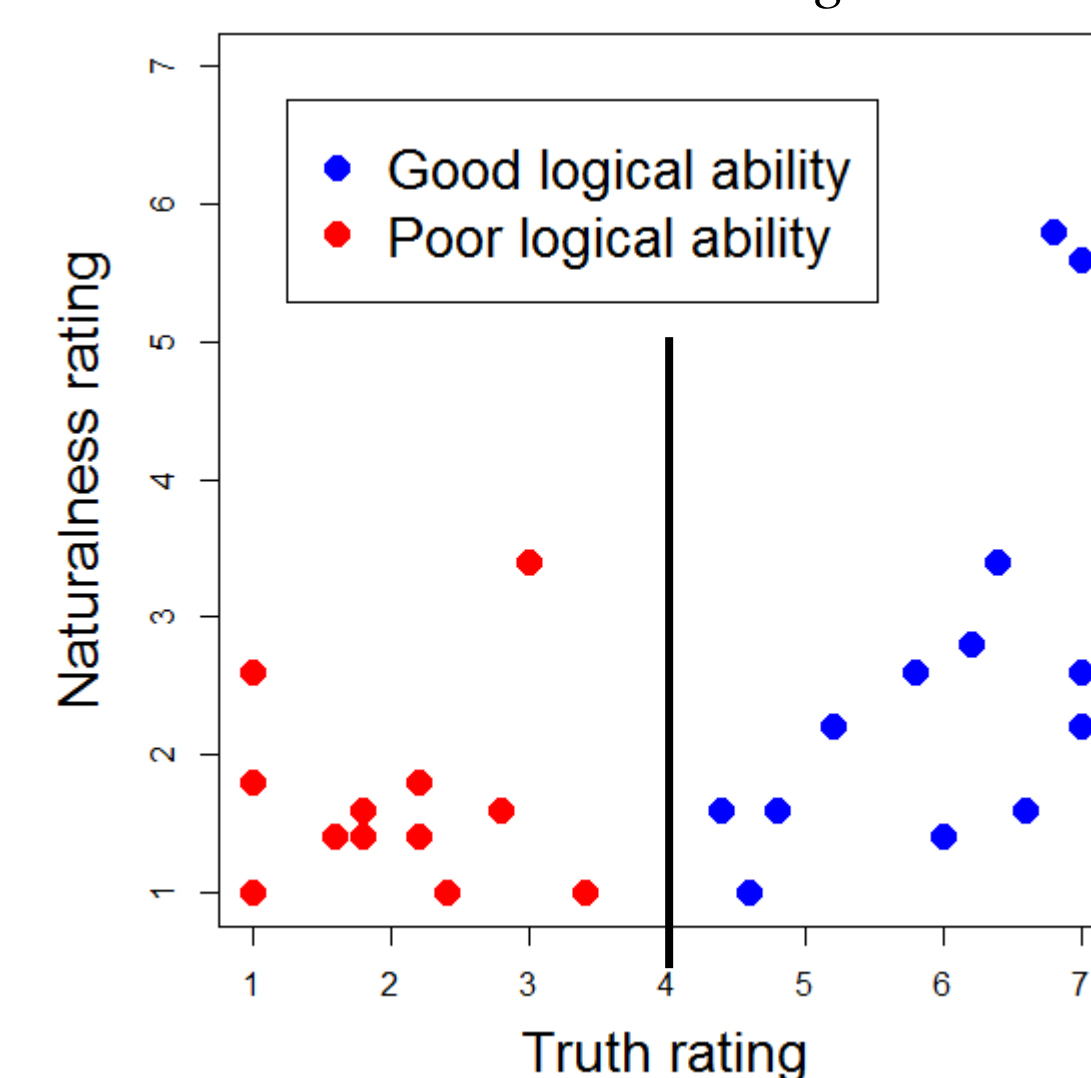
Participants and Procedure

- *Participants*: 27 right-handed native speakers of Mandarin
  - 14 with good logical ability, 13 poor logical ability

- *Procedure*: Picture followed by auditory sentence; task during recording was to rate sentence-picture consistency on a 1-7 Likert scale. Offline ratings collected after ERP recording.

ERP Results

ERPs at the quantifier some of: grand average over all participants

- Pragmatic violation
- Correct "some"
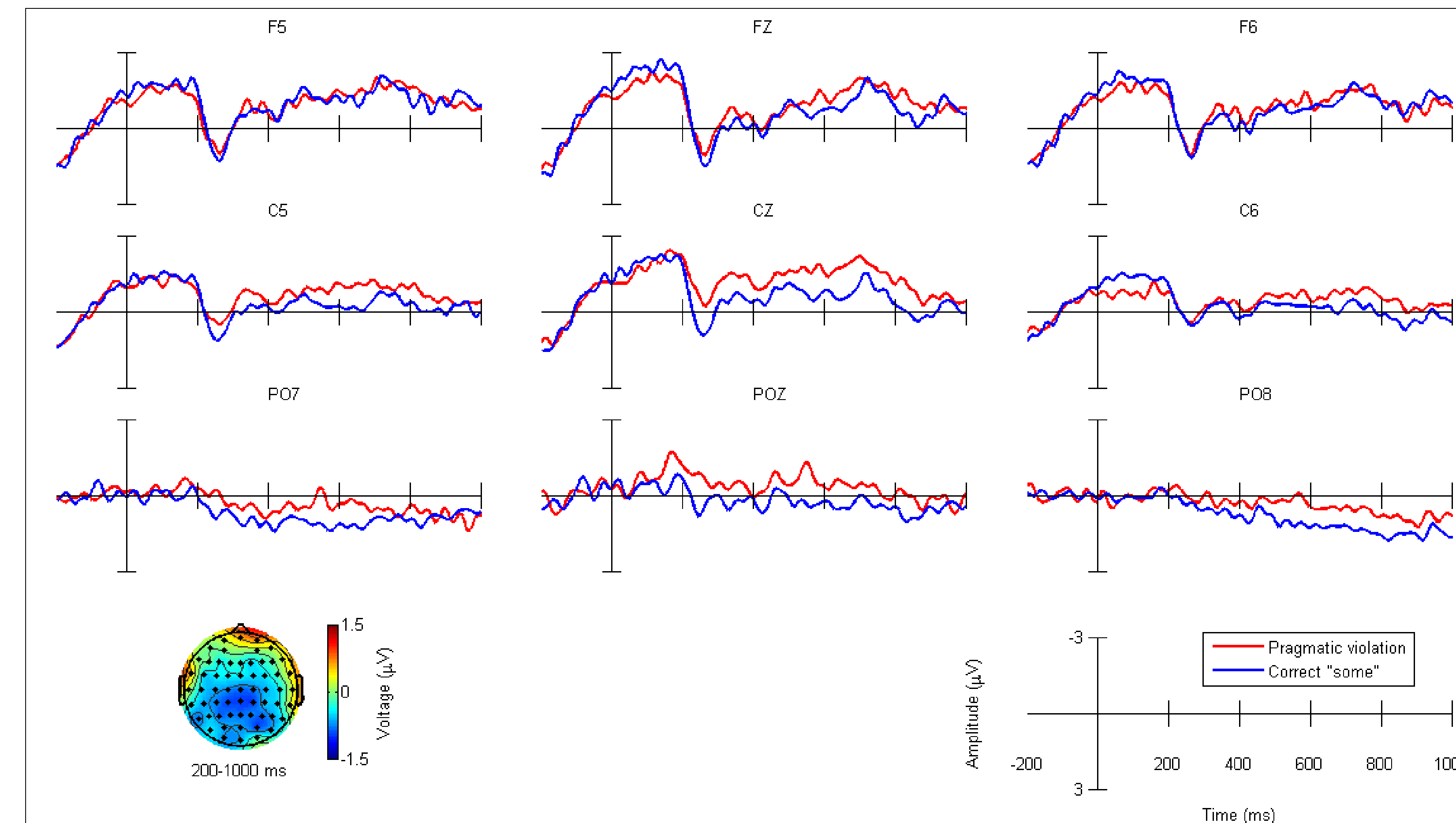
- Pragmatically inconsistent quantifiers elicited centro-posterior sustained negativity in the 200-1000ms time window (*p* = .015)

Pragmatically inconsistent quantifiers

Semantically inconsistent quantifiers
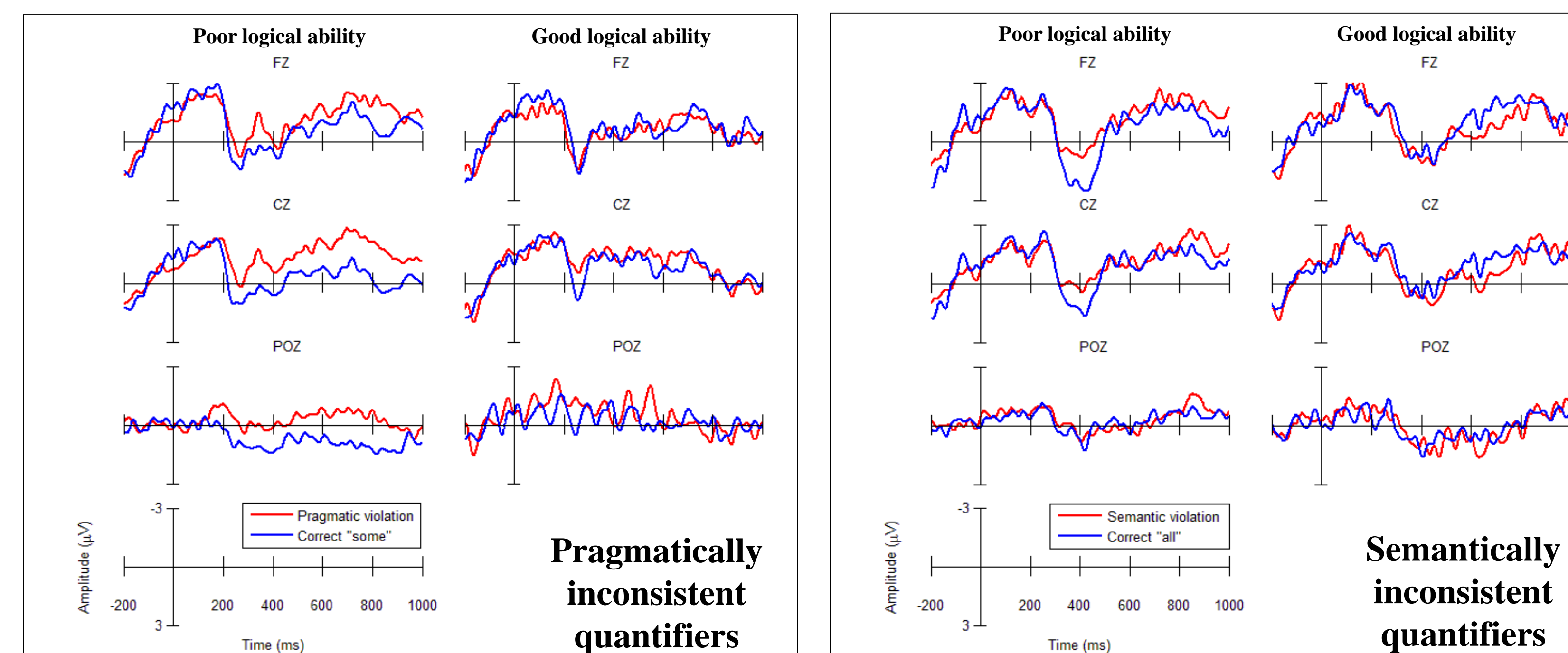
- Sustained negativity driven by participants who were poor at realizing semantic meaning (Consistency × Group, *p* = .033; above left)

- No such group difference in semantically inconsistent fillers in the 200-1000 or 300-500 ms time windows (*p*s > .247, above right)

Materials and EEG Methodology

- *Materials*:
  - Critical items: 80 picture sets (40 trials per condition).
  - 80 fillers with *all of* (40 semantically inconsistent, 40 semantically consistent)
  - 160 additional fillers (80 correct, 40 each with violations at the object and verb)
    - Fillers all used either *some of* or *all of*

- *EEG Acquisition & Analysis*: 64 channel 10-20 cap (Brain Products, Inc.). Recorded at 1000 Hz with 0.016 – 100 Hz bandpass (Brain Products Brainamp amplifier), re-referenced to averaged mastoids, 0.5 Hz high-pass filter, ocular artifact removed using ICA (Makeig et al., 1996), baseline correction (200 ms pre-stimulus), Huynh-Feldt repeated measures ANOVAs.

Behavioral Results

Consistency ratings for critical sentences (N=26)

- Pragmatically inconsistent
- Correct "some"
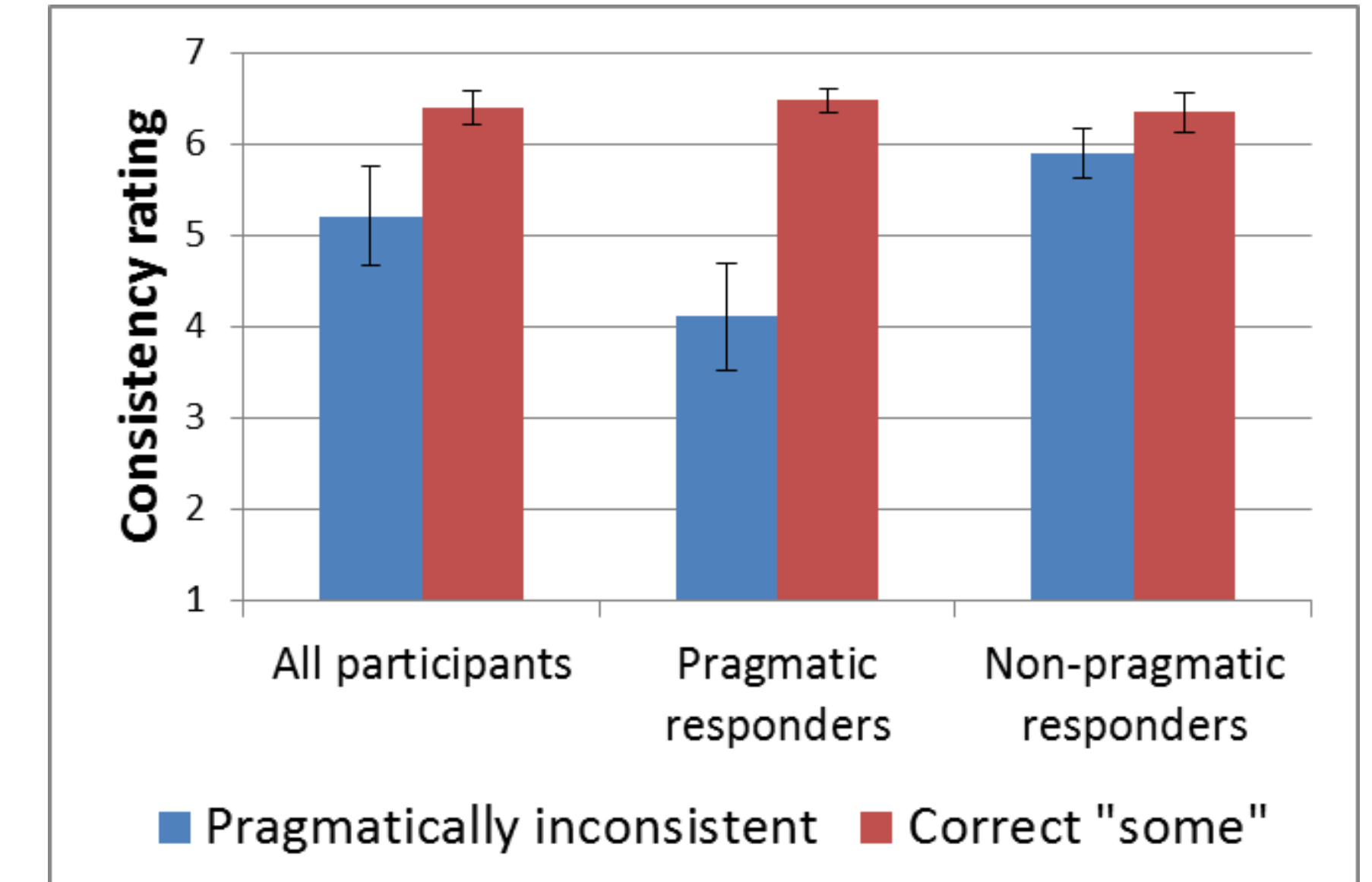
- Correct *some of* sentences rated higher (in consistency with picture) than pragmatically inconsistent sentences: $t(25) = -4.69$, $p < .001$

- 10 participants reliably rated correct sentences higher than inconsistent (*pragmatic responders*)
- 16 did not (*semantic* or *inconsistent responders*)

- Unlike truth/naturalness judgments, consistency ratings did not predict ERP responses.

Discussion

- Pragmatically infelicitous scalar inference in *some of* triggers sustained negativity
  - Replicates Politzer-Ahles et al. (in press)
  - Likely to be associated with reinterpreting the quantifier (similar sustained negativities for revision of discourse models: Baggio et al., 2008; Pijnacker et al., 2011)

- Negativity is greatest in comprehenders who are also poor at realizing the semantic meaning

- Negativity may reflect effort needed to retrieve the semantic meaning of *some of* in order to construct a felicitous representation of the sentence

References

- Baggio et al. (2008). *J. Mem. Lang., 59*, 36-53.
- Dieussaert et al. (2011). *Quart. J. Exp. Psych., 64*, 2352-2367.
- Makeig, Bell, Jung, & Sejnowski (1996). *Advances in neural information processing systems 8*, 145-151. MIT Press.
- Nieuwland, Ditman, & Kuperberg (2010). *J. Mem. Lang., 63*, 324-46.
- Pijnacker et al. (2011). *J. Cogn. Nsci, 23*, 471-480.
- Politzer-Ahles, Fiorentino, Jiang, & Zhou (in press). *Brain Res.*