

An ERP investigation of the processing of binomial expressions in sentence context: *Safe and sound vs. Sound and safe.*

Background

In an ERP experiment, we investigated the processing of English **binomial** expressions. Binomials are recurrent expressions formed by two words from the same lexical class connected by a conjunction (e.g. *safe and sound*), in which a particular word order is more frequent and considered more acceptable (e.g., *safe and sound* vs. *sound and safe*).

It is generally accepted that we store representations of words in our mental lexicon. However, what exactly is stored remains an open question. Previous research has looked at whether **multi-word units** (e.g., idioms, phrasal verbs, collocations, and compounds) are stored holistically or computed on-line. There is reason to believe that the brain stores and processes such multi-word units as wholes, as vast amounts of knowledge can be stored in long-term memory, but only relatively small amounts can be processed in real-time. In effect, the brain may make use of a relatively abundant resource (long-term memory) to compensate for a relative lack in working-memory by storing a number of frequently used multi-word units as wholes.

The present study is based on the assumption that the lexicon of a native speaker consists of a large number of lexicalised units, where a unit “is a structure that a speaker has mastered quite thoroughly, to the extent that he can employ it in a largely automatic fashion, without having to focus his attention specifically on its individual parts or their arrangement” (Langacker, 1987).

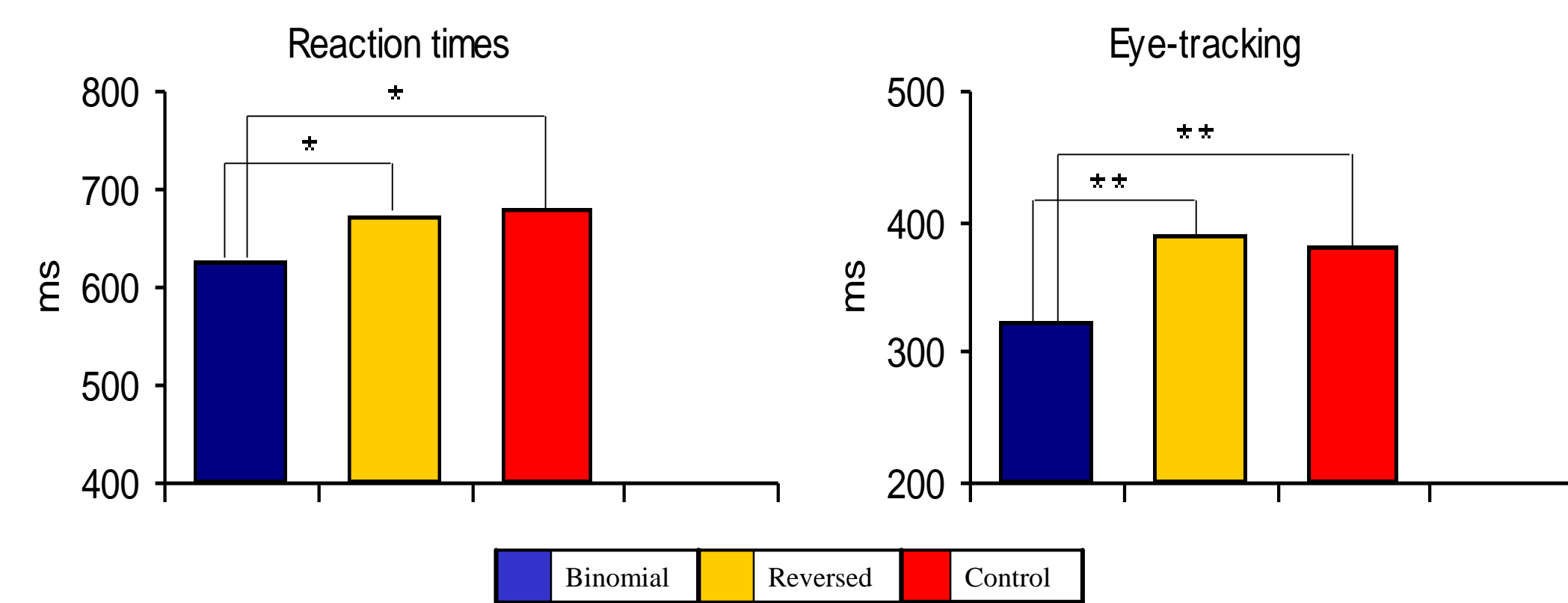
The **aim** of the current study is to investigate the processing of frequent binomials vs. their infrequent reversed forms and nonsense phrases using ERPs.

Previous Research

Binomial: The company suspended its production of | food and drink | due to poor hygiene.

Reversed: The company suspended its production of | drink and food | due to poor hygiene.

Control: It is believed that the | form and style | of the palace will remain unchanged.



- shorter reading times to binomials than to reversed forms
- shorter reading times to binomials than to controls
- no differences in reading times to reversed forms and controls (Siyanova & Conklin, in submission)

Present Study

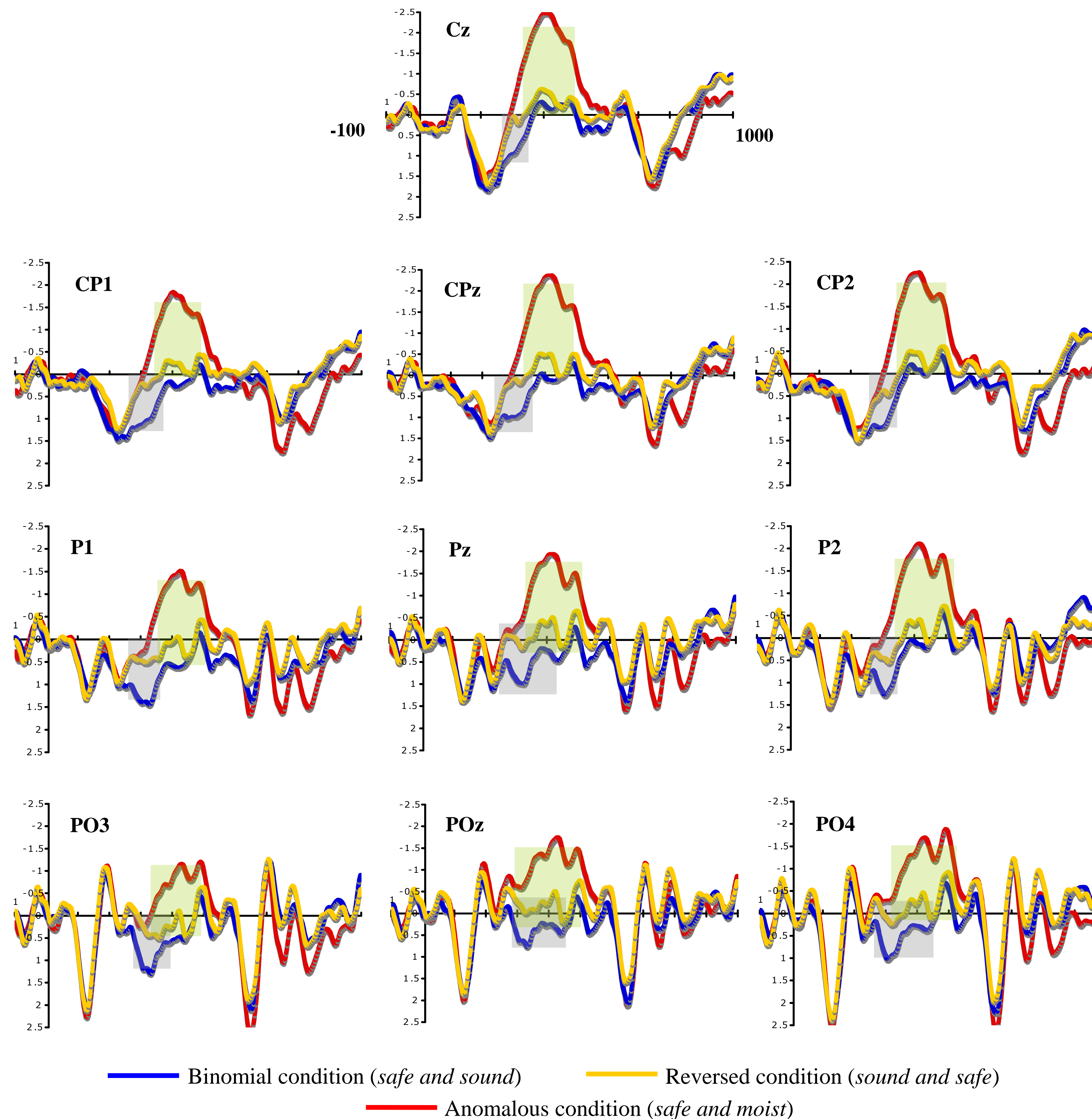
This study looks at the processing of binomials in sentence context using ERP. Of interest is the N400 component, which has been shown to be sensitive to the processing of lexical-semantic information and frequency, as well as real-world knowledge (e.g., Kutas & Hillyard, 1980; Hagoort et al., 2004). If binomials are stored holistically, we expect to see larger N400 amplitudes for the reversed condition than for the binomial condition. Furthermore, we predict the largest N400 waves for the semantically anomalous condition.

Materials and Design

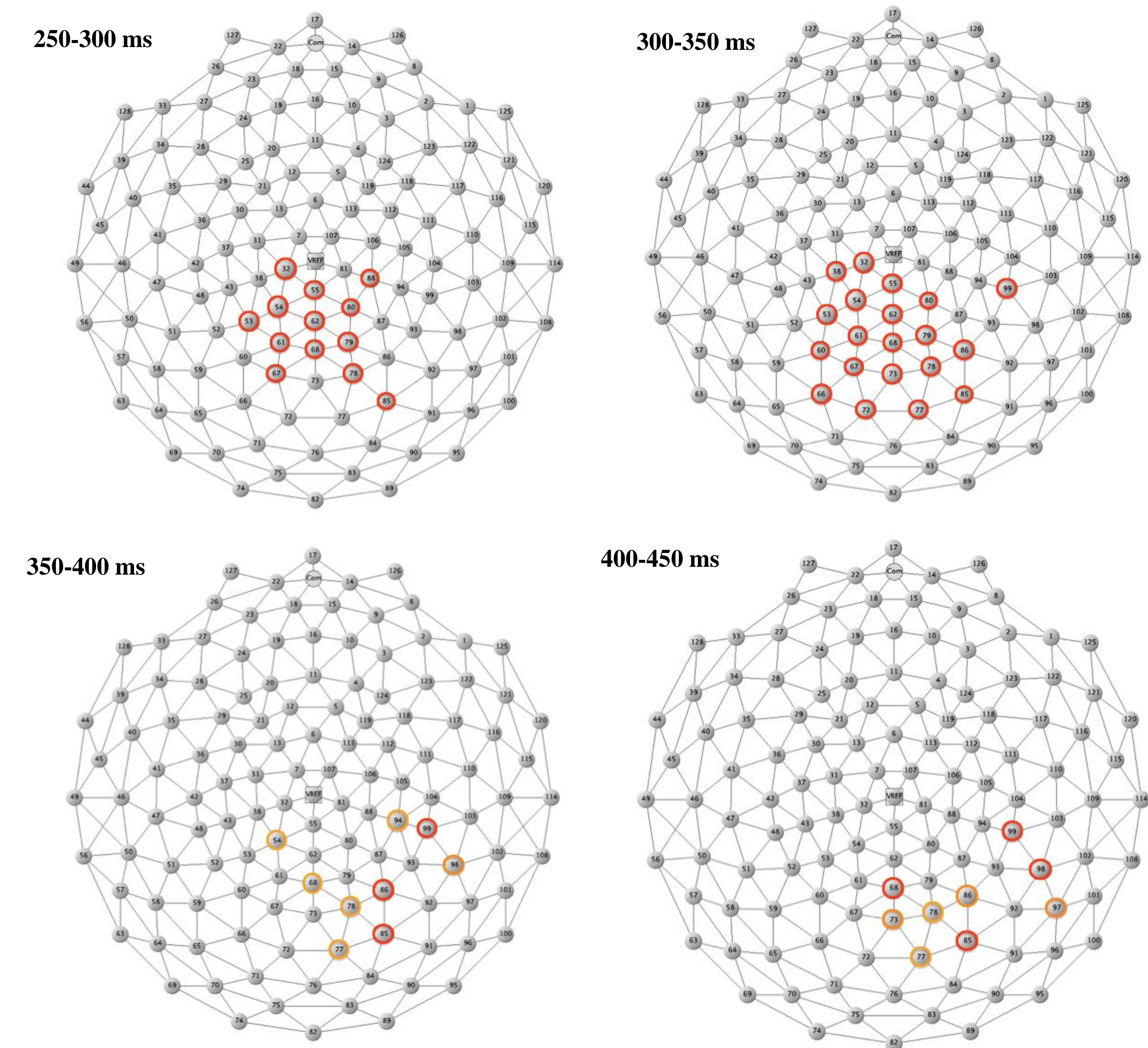
- three phrase types:
 - 180 binomials (*safe and sound*), Mean freq. = 184
 - 180 reversed forms (*sound and safe*), Mean freq. = 20
 - 180 anomalous phrases (*safe and moist*), Mean freq. = 0
- individual word frequency and length were matched across the three conditions. Semantic association strength was matched in the binomial and reversed condition
- embedded in sentence contexts
 - Binomial:** Jim was back safe and sound despite his numerous adventures.
 - Reversed:** Jim was back sound and safe despite his numerous adventures.
 - Anomalous:** Jim was back safe and moist despite his numerous adventures.
- three participant lists
- each participant read: 60 binomials, 60 reversed forms, 60 nonsense phrases, and 120 fillers
- participants: 45 right-handed native speakers of English
- procedure: sentences presented using RSVP, 25% followed by a comprehension question
- system:
 - Net Station for E-Prime & EGI 128 channel EEG system
 - collects EEG at 250 samples per second
 - Lowpass 40 Hz filtering
- analysis: 6.3% of the data were lost due to movement, blinks and other artifact

Results

ERPs evoked by the final word of the binomial, reversed and semantically anomalous conditions (shaded areas represent significant differences between the conditions).



Binomial vs. reversed condition (red circles represent $p < .05$, orange circles represent $.04 < p < .09$)



Conclusion

As predicted, our results revealed a significantly larger N400 for the semantically anomalous condition (*safe and moist*) relative to both binomials (*safe and sound*) and their reversed forms (*sound and safe*). The N400 amplitude for the semantically anomalous condition peaked around 400 ms after the onset of the critical word (Word 3). Importantly, it was found that reversed forms (*sound and safe*) elicited significantly larger N400 than binomials (*safe and sound*). The ERPs elicited by binomials and their reversed forms have a smaller amplitude than those of the semantically anomalous condition. Further, the difference between binomials and reversed forms is only significant in an early window, around 250 - 350 ms.

The N400 elicited by the semantically anomalous condition was significantly larger than those of the binomial and reversed forms. This replicates findings in the literature showing larger N400 for words that do not make sense in a given context (Kutas & Hillyard, 1980). Crucially, the N400 elicited by reversed forms was significantly larger than the N400 of binomials, indicating that reversed forms, which are less frequent, take more processing effort to integrate into the unfolding meaning of the sentence than binomials. These findings replicate those obtained in eye-tracking and reaction time experiments (Siyanova & Conklin, in submission), and as such support a view in which lexical storage is maximized, while on-line computation is minimized.

References

- Hagoort, P., Hald, L., Bastiaansen, M., and Petersson, K. (2004). Integration of word meaning and world knowledge in language comprehension. *Science*, 304, 438-441.
- Kutas, M. and Hillyard, S. (1980). Reading senseless sentences: brain potentials reflect semantic incongruity. *Science*, 207, 203-205.
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