Theta and Beta Changes Related to Learning New Words from Linguistic Context

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BACKGROUND

Adults acquire most of their vocabulary via learning from context. The processes related to this task are, to a large degree, unknown or unavailable to the learner. ERPs provide a non-invasive, objective way to study learning from context [1-4] but do not identify the mechanisms involved in word learning.

Studying the neural oscillations underlying word learning may increase our understanding of the cognitive process related to this ability. Specifically:

•Theta power increases (4-8 Hz) often relate to semantic retrieval and integration [5-7].

•Upper beta power increases (20-30 Hz) have been observed in the resolution of a semantic search process [8-9].

PURPOSE

Identify neural oscillations and related cognitive functions underlying word learning from linguistic context.

METHODS

Participants:
20 Right-handed, monolingual English speaking adults

EEG Equipment:
Neuroscan EEG System, 62 electrode cap, 1000 Hz data collection

Procedure:
•42 sets of 3 sentences, each ending with a novel word, were presented word-by-word on a screen in front of the participant.
•After each triplet the participant was asked to identify the target word's meaning

Two conditions (21 triplets each):

- Meaning – sentences increasingly support the target word's meaning.
- No Meaning – sentences do not provide enough semantic information to determine the target word's meaning.

Meaning Triplet: Sentences increasingly constrain the word's meaning

Sentence 1: Her | parents | bought | her | a | pav. | +

Sentence 2: The | sick | child | spent | the | day | in | his | pav. | +

Sentence 3: Mom | piled | the | pillows | on | the | pav. | +

No Meaning Triplet: All low probability sentences for words that are not used in the study.

Sentence 1: Her | favorite | toy | of | all | time | is | the | zat. | +

Sentence 2: He | had | a | lot | of | food | on | his | zat. | +

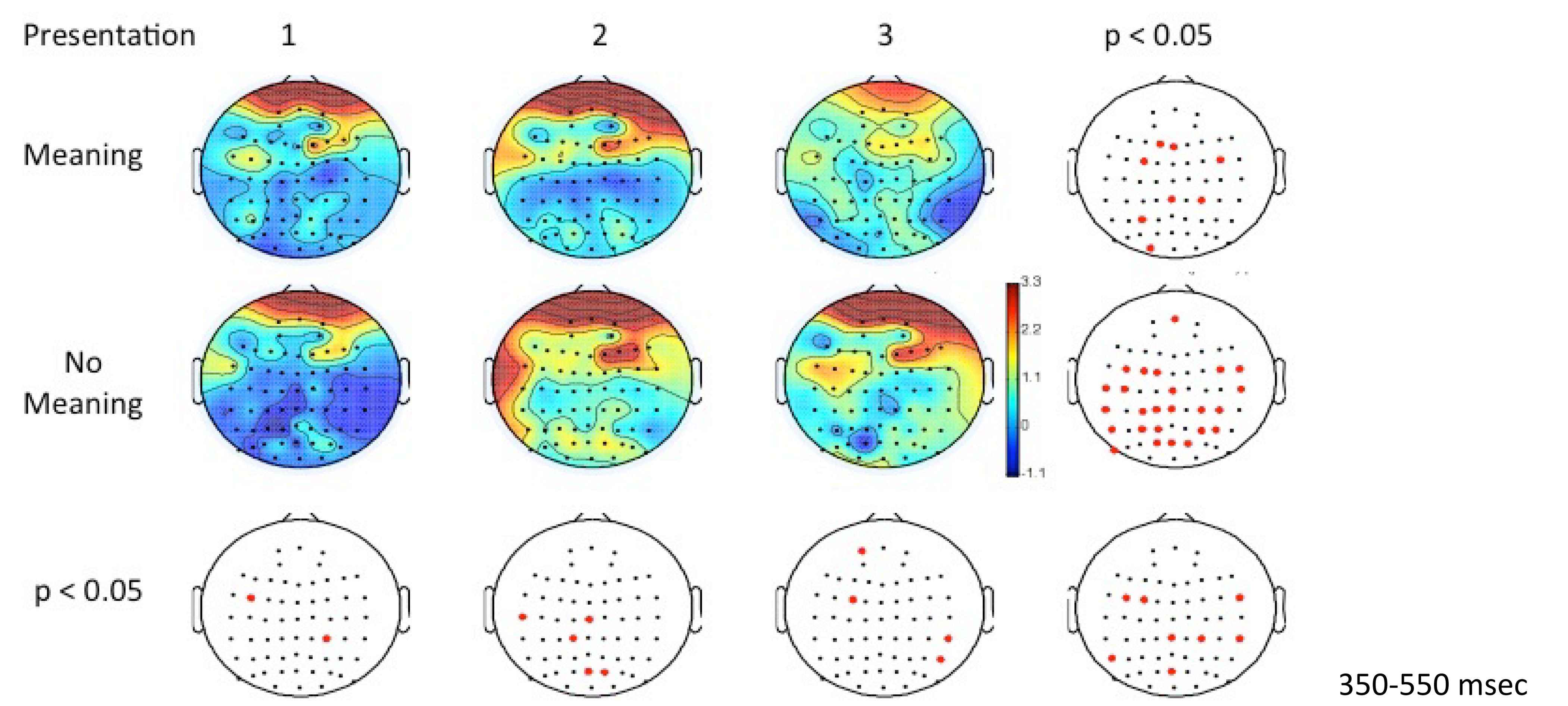
Sentence 3: Before | bed, | I | have | to | take | a | zat. | +

ACCURACY

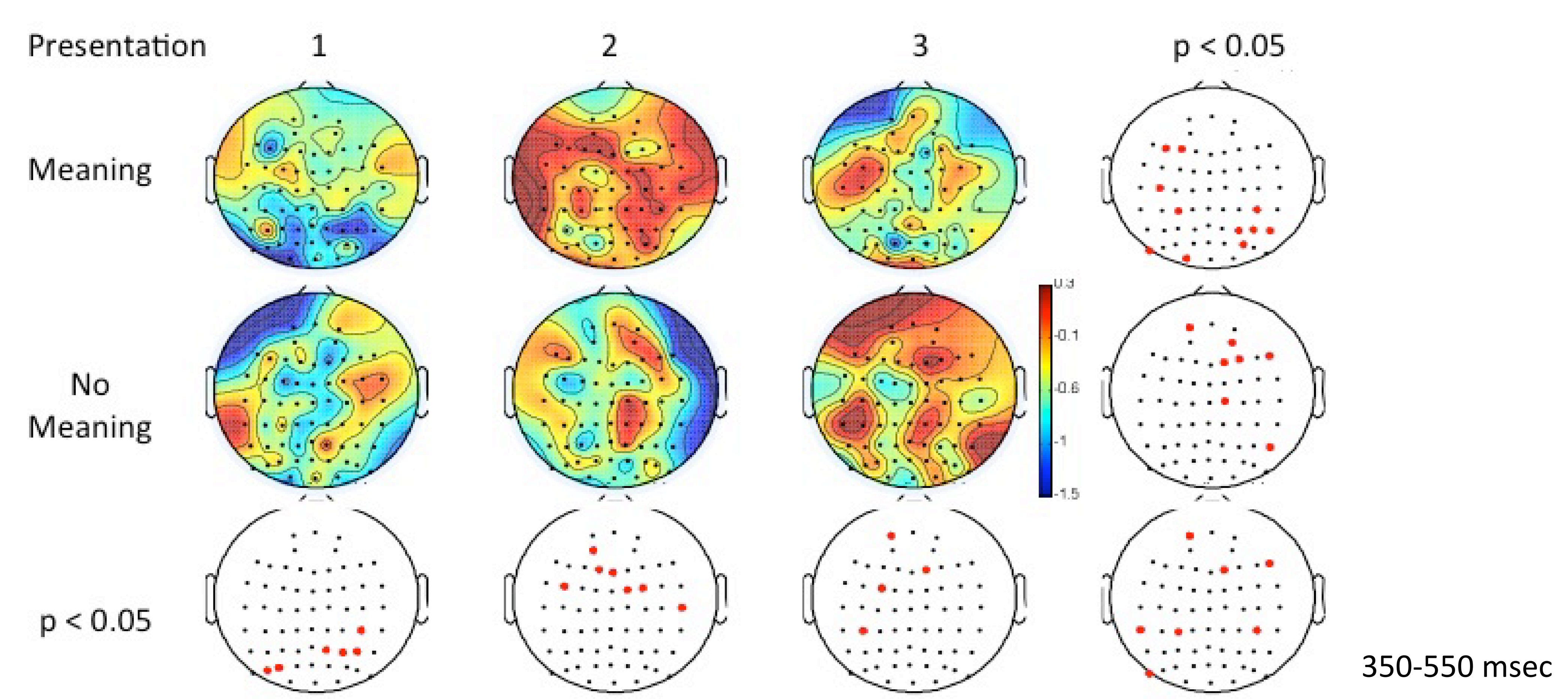
Meaning : 81.2% (SD = 12.5), No Meaning = 72.4% (SD = 18.7)

THETA RESULTS (4-8 Hz)

EEG epoched to the target novel word for each word learning presentation.



UPPER BETA RESULTS (20-30 Hz)



EEG ANALYSIS

- Epoched (-500-1500 msec) data were Fourier transformed, magnitude squared, and normalized
- Power spectrum data were averaged across trials and subjects and computed using the log power values minus the baseline
- The mean baseline power at each electrode and frequency was subtracted
- 2 (Meaning, No meaning) x 3 (presentation) ANOVA with statistical significance ($p < 0.05$) determined using random permutation statistical analysis

CONCLUSIONS

THETA

Findings: Increases with each exposure; somewhat larger in the *no meaning* versus *meaning* condition.

Interpretation: Integrating semantic information, attempting to identify word meaning. This is harder when there is no meaning.

UPPER BETA

Findings: Peaks in second presentation for *meaning condition* and third presentation for *no meaning condition*

Interpretation: Resolution of the semantic search. In the *meaning condition* this is related to identifying the word's meaning. In the *no meaning condition* this is identifying the lack of one coherent representation.

DISCUSSION

Our goal was to identify the mechanisms underlying successful word learning.

Although theta, which is traditionally related to semantic processing, is important to the semantic search, beta appears to be the better measure of when the meaning of a new word is identified.

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