

# When do words get in the way? An EEG investigation of the interaction of talker and linguistic cues in speech processing

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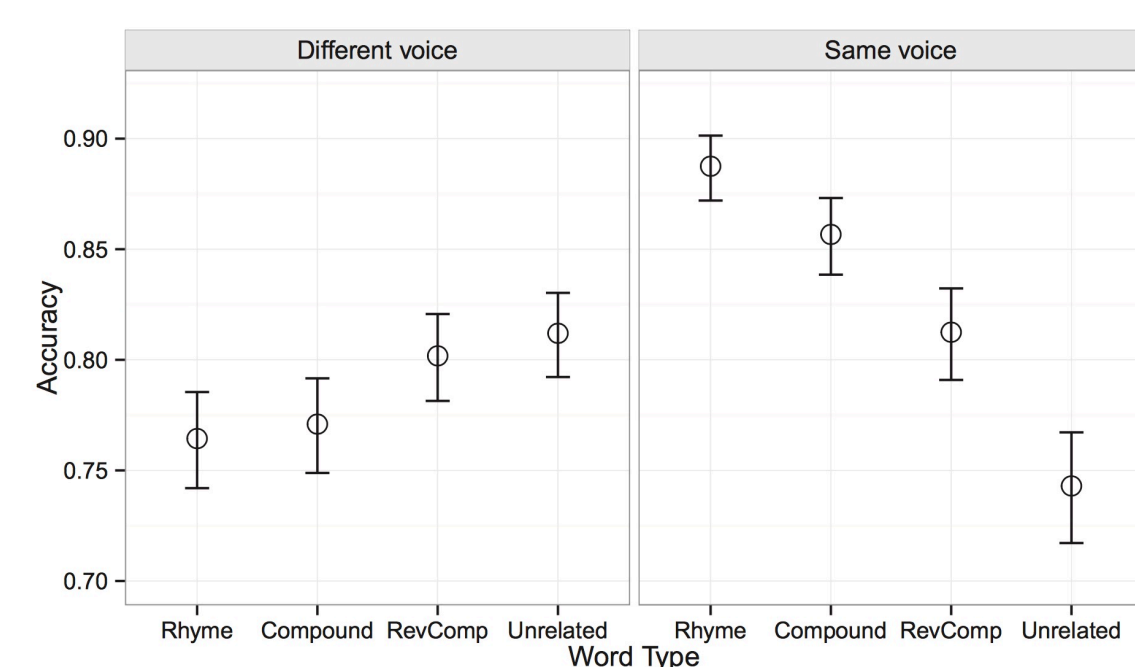
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## BACKGROUND

- Linguistic- and talker-specific information segregated early in cortical processing [1,2]
- Talker discrimination accuracy affected by linguistic relatedness of two words in sequence [3]



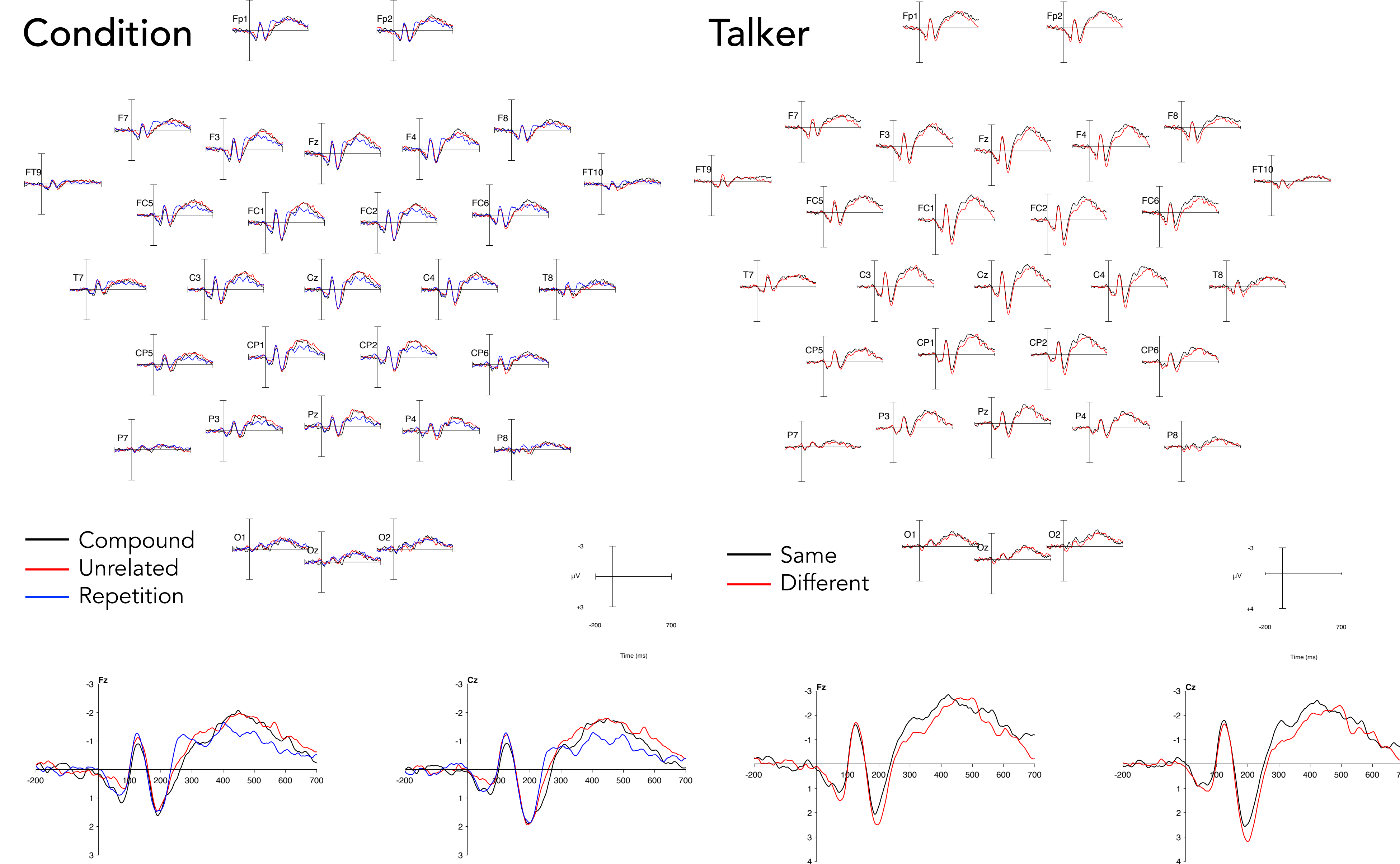
- Accuracy poorer when same talker produced unrelated (tooth-bread) compared to linguistically related words (tooth-paste)
- When different talkers produced words forming compound, discrimination of voices was worse compared to unrelated words.

- Low-level discrimination affected by top-down linguistic processing of words

## Questions:

1. Do listeners expect words produced by same talker to be linguistically related?
2. What is neurophysiological time-course of integrating linguistic- and talker-specific information during language processing?

## RESULTS: ERPs



- Maximal mixed effects model:
  - Fixed effects: Condition (Compound, Repeated, Unrelated), Talker (Same, Different)
  - Random effects: Random intercept, random by-participant slopes for Condition and Talker
- Across all channels

N1: 100-150 ms

Condition	$F(2,22) = 2.13, p = 0.14$
Talker	$F(1,22) = 0.02, p = 0.89$
Condition x Talker	$F(2,4046) = 1.56, p = 0.21$

P2: 150-250 ms

Condition	$F(2,22) = 2.87, p = 0.08$ .
Talker	$F(1,22) = 4.14, p = 0.05$ .
Condition x Talker	$F(2,4046) = 6.05, p < 0.01^{**}$

Post-hoc (holm correction)

Unrelated / same-different:  $\chi^2(1) = 9.38, p < 0.01^{**}$

Same / compound-repeated:  $\chi^2(1) = 7.25, p < 0.05^*$

Same / compound-unrelated:  $\chi^2(1) = 5.81, p = 0.08$ .

Late Negativity: 300-500 ms

Condition	$F(2,22) = 1.14, p = 0.39$
Talker	$F(1,22) = 2.62, p = 0.12$
Condition x Talker	$F(2,4046) = 3.27, p < 0.05^*$

	Pre-hoc	Post-hoc (holm correction)
Pre-hoc	0.000000	0.000000
Post-hoc (holm correction)	0.000000	0.000000

Repeated / same-different:  $\chi^2(1) = 6.02, p < 0.05^*$

## METHODS

## Participants and procedure

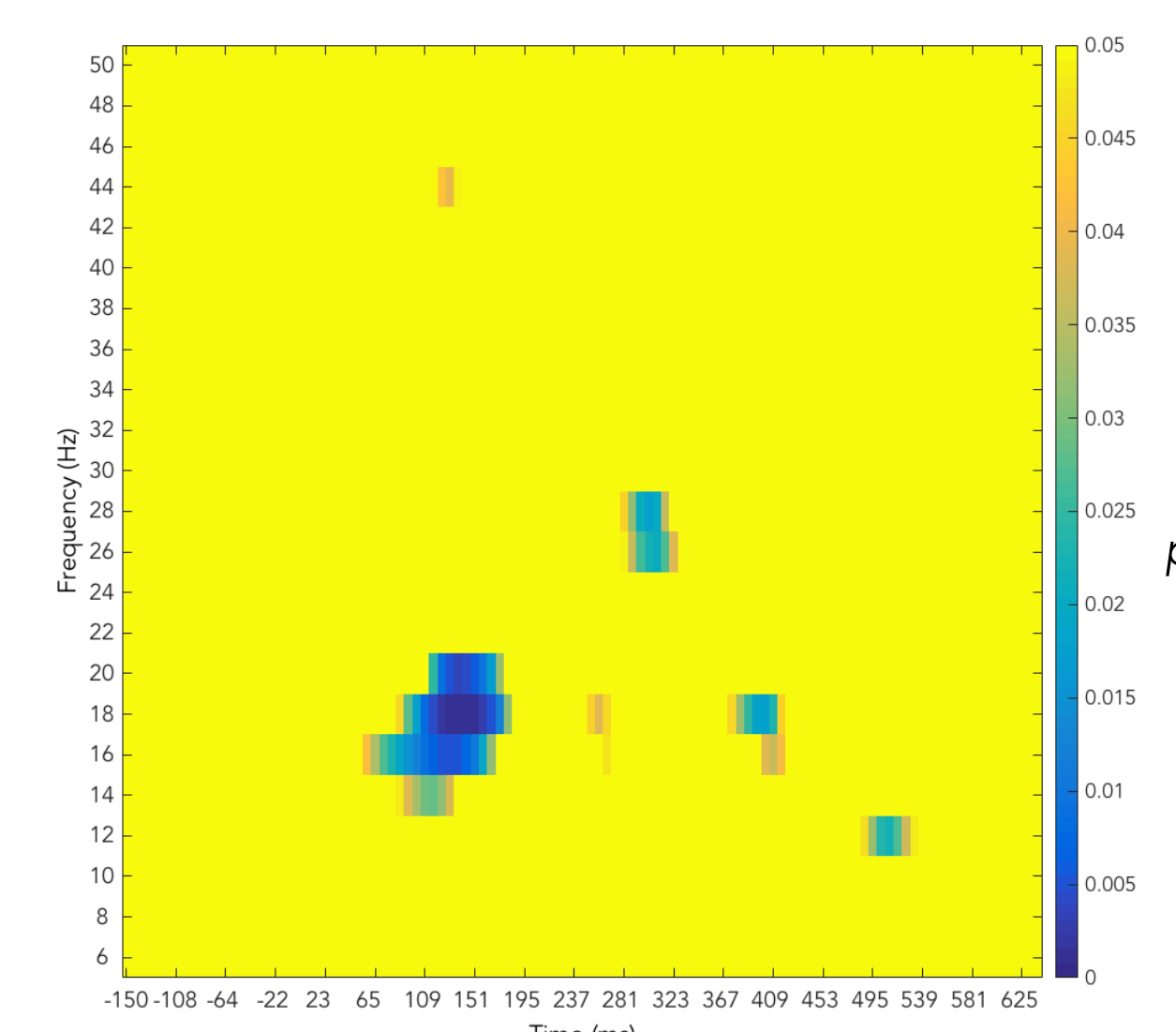
- 23 native English speakers (15 F, mean age 19.5 yrs)
- Listened to 90 auditory pairs of monosyllabic words
  - Each pair presented four times (360 total trials)
  - ½ trials same talker, ½ trials two talkers
    - Two male English native speakers
  - Pairs formed three linguistic relationships
    - Compound, Unrelated, Repeated

Condition Talker	Compound	Unrelated	Repeated
Same	bed <sub>1</sub> bug <sub>1</sub>	bed <sub>2</sub> brow <sub>2</sub>	bed <sub>1</sub> bed <sub>1</sub>
Different	bed <sub>1</sub> bug <sub>2</sub>	bed <sub>2</sub> brow <sub>1</sub>	bed <sub>1</sub> bed <sub>2</sub>

subscripts refer to talker identity

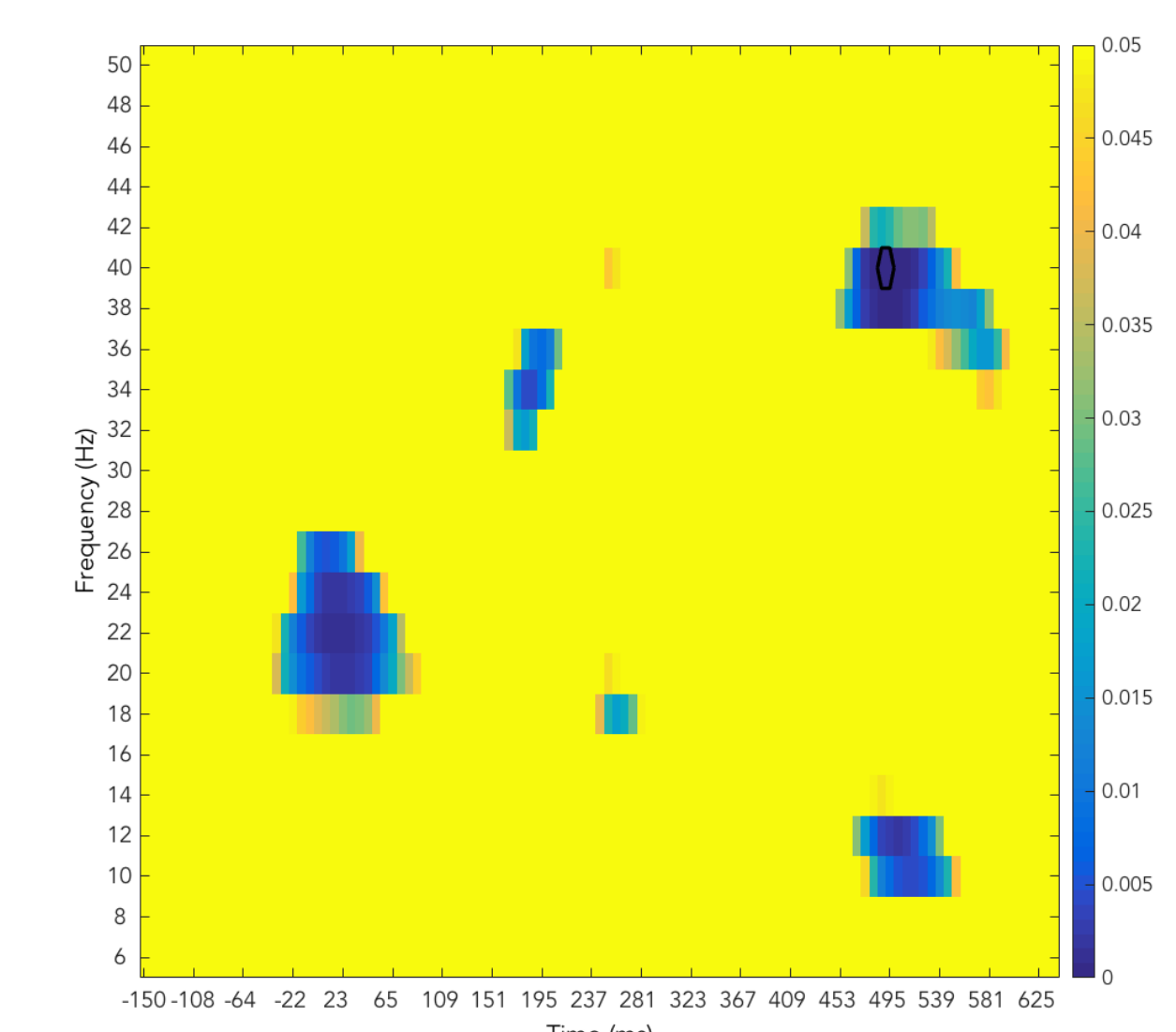
- 32-channel whole-head EEG (Brain Products)
- Participants passively listened while watching silent movie
- Impedances maintained below 20 k $\Omega$
- 500 Hz sampling frequency; 0.01 – 200 Hz online BPF
- Triggers time-locked to onset of second word
- Linked mastoid reference channels
- Ocular and muscular artefacts removed using ICA

## RESULTS: TF



## Unrelated: Same/Different

- $\beta$ -band oscillatory power differences reflects talker change at  $\sim 100$  ms
- Likely too early to result from linguistic relatedness
- Reflects change in talker



Same: Repeated/Unrelated

- Late  $\gamma$ -band oscillatory power differences reflect repeated versus unrelated words
  - Only when talker is the same
- Early  $\beta$ -oscillatory power differences
  - Too early to reflect Condition

## DISCUSSION

- Earliest signs of talker change evident at ~150 ms
- Linguistic relatedness observable only when no talker change  
Listeners expect linguistic relatedness when spoken by same talker
- What level of linguistic relatedness do listeners expect from same speakers, e.g., lexical, semantic, syntactic?
- Would different relationship types between words produce different neurophysiological signatures?

## REFERENCES

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2. Kaganovich N et al. Electrophysiological evidence for early interaction between talker and linguistic information during speech perception. *Brain Res* 2006; 1114 : 161–172.
3. Narayan CR et al. Words Get in the Way: Linguistic Effects on Talker Discrimination. *Cognitive Science* 2016; 41: 1361–1376.

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