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Is Motor Activation Necessary For Action Language Processing? Evidence From EEG

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INTRODUCTION

Classical models of language comprehension view language representation as amodal and independent from perceptual and motor systems (Fodor, 1980, 1987; Caramazza, 2009)
 The embodied cognition framework suggest that linguistic representations are multimodal and involve perceptual and motor systems (Wilson & Golonka, 2013; Barsalou, 1999, 2008)
 Neuroimaging studies show an overlap between motor and linguistic processing (Hauk, Johnsrude & Pulvermuller, 2004; Tettamanti, Buccino, Saccuman, Gallese, 2005; Aziz-Zadeh, Wilson, Rizzolatti, Iacoboni, 2006)
 Action-sentence compatibility effect (ACE) (Glenberg & Kaschak, 2002)

Is motor activation *necessary* for processing language?

Or are motor processes merely reactivated by linguistic representations (post-lexical)?

EEG used to examine the precise timing of the bidirectional impact between lexical processing on movement and vice-versa (Aravena, 2002)

Our study explores the functional role of motor activity during language comprehension using EEG

METHODS

Twenty participants (12 women, age: 21-27)

40 auditory sentences implying either a movement away from or towards their body, plus 20 semantically anomalous fillers

Ex. TOWARDS

Emile a pris son verre de vin et l'a bu
 [Emile took his glass of wine and it drank]
 Emile took his glass of wine and drank it

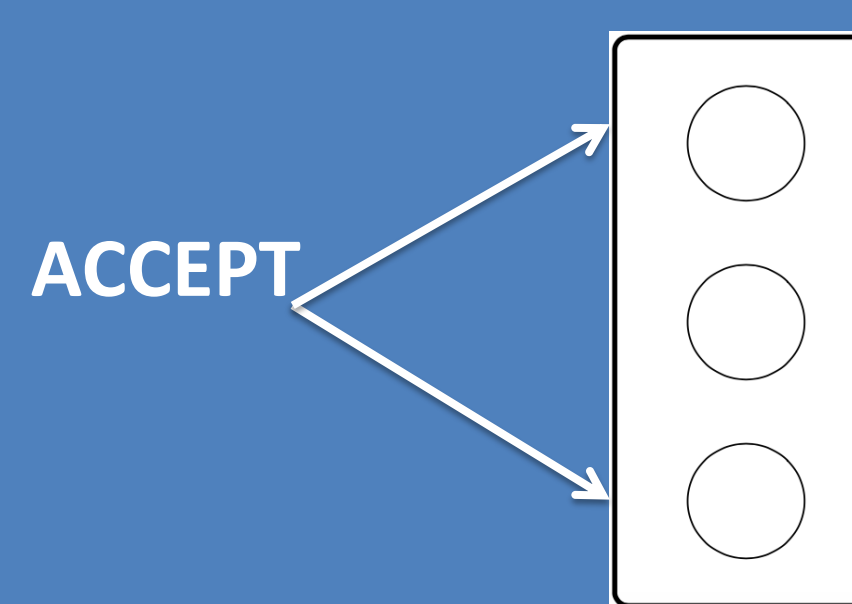
Ex. AWAY

Suzanne a pris les cartes et les a distribuées
 [Suzanne took the cards and them distributed]
 Suzanne took the cards and distributed them

Ex. Semantically anomalous

Jules a pris ses neurones et les a distribués
 [Jules took his neurones and them distributed]
 Jules took his neurones and distributed them

Participants made semantic judgments and responded positively either toward or away from their body



EEG: Biosemi 64 active electrodes

Time-locked to motor response:

Motor Preparation: -50 to 90 ms time window
 N400: 300- 500 ms time window

Time-locked to onset of critical word (verb):

Motor Preparation: -50 to 90 ms time window
 N400: 300- 500 ms time window

LME performed on RT data and GLMER performed on accuracy data

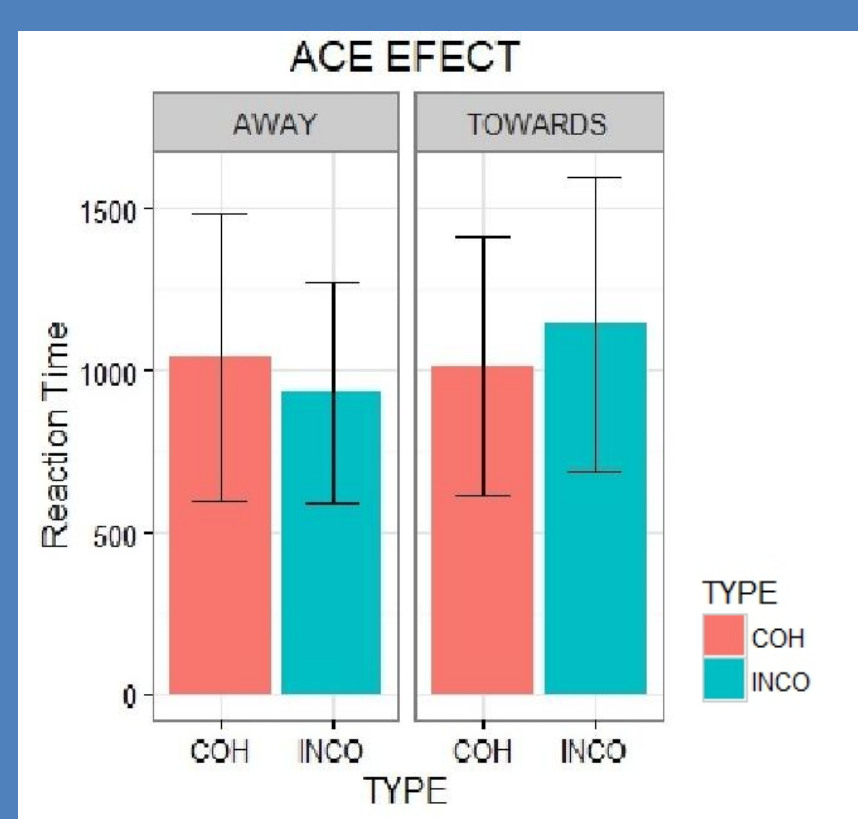
RESULTS

RT Results

Interaction: Type x Condition
 $B = 54.57$, $Se = 23.10$, $t = 2.36$, $p < .03$

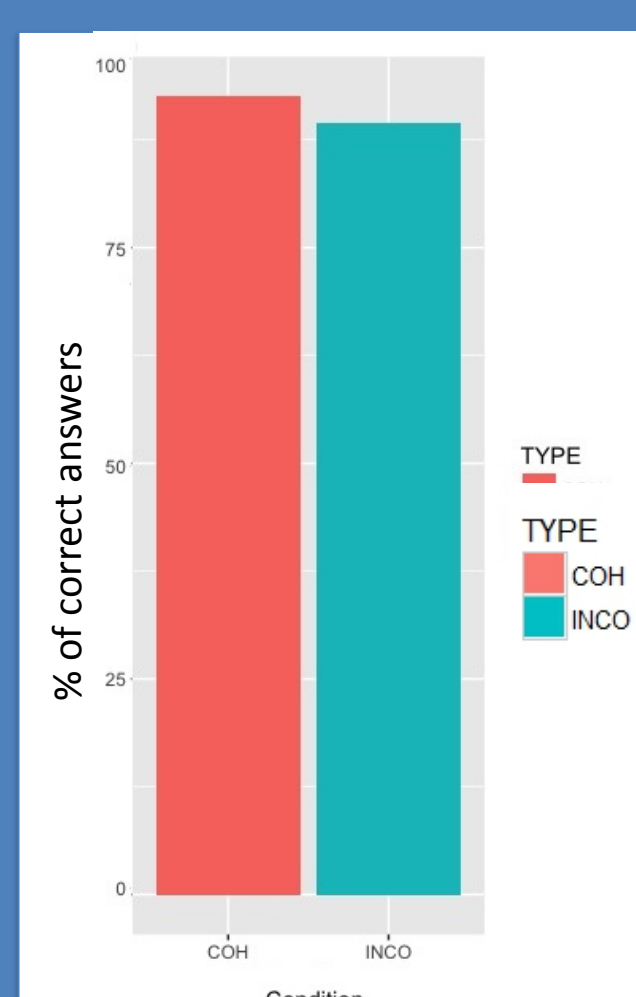
Away Condition: no effect of coherency
 $B = -116.99$, $Se = 82.07$, $t = -1.43$, $p = .19$

Toward Condition: significant effect of coherency
 $B = 102.87$, $Se = 46.20$, $t = -2.23$, $p < .03$



Accuracy Results

Accuracy was at ceiling level
 (GLMER models failed to converge due to lack of variance)

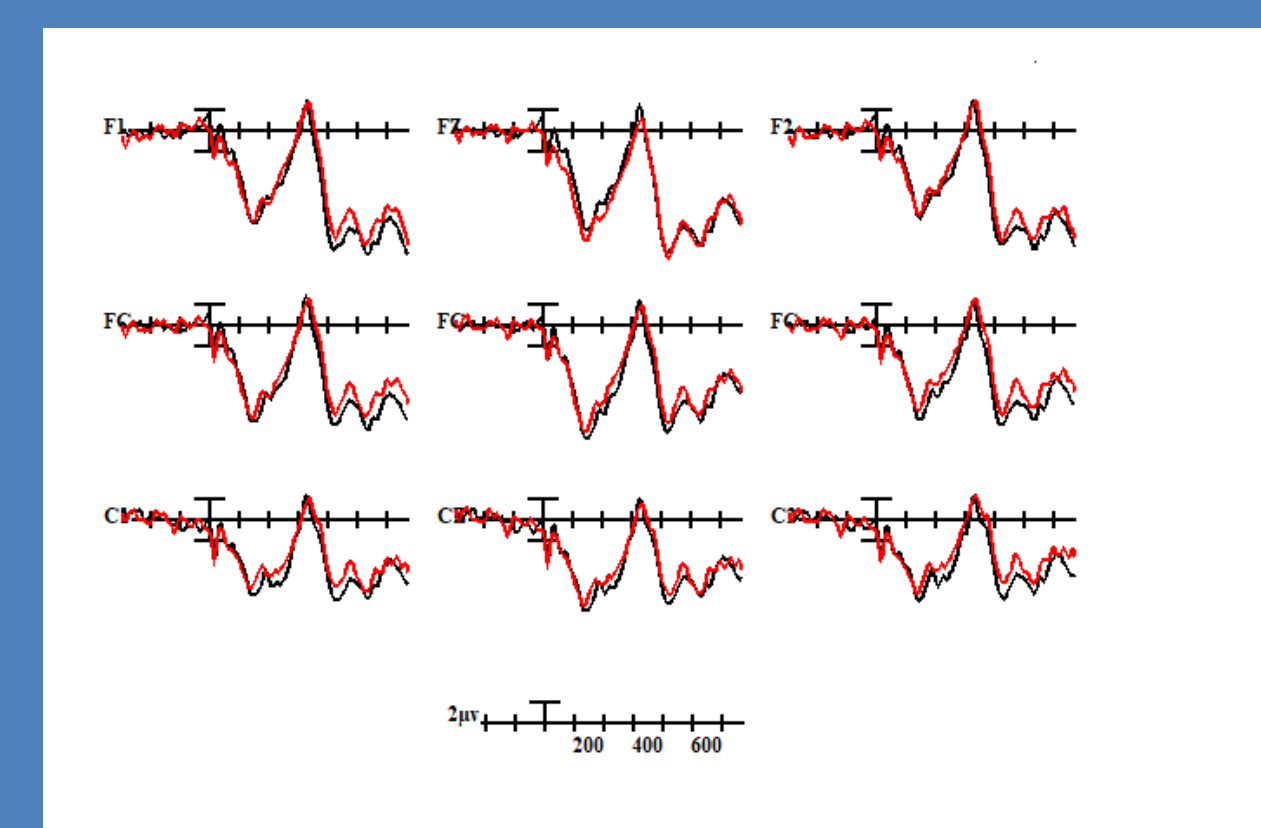


ERP Results

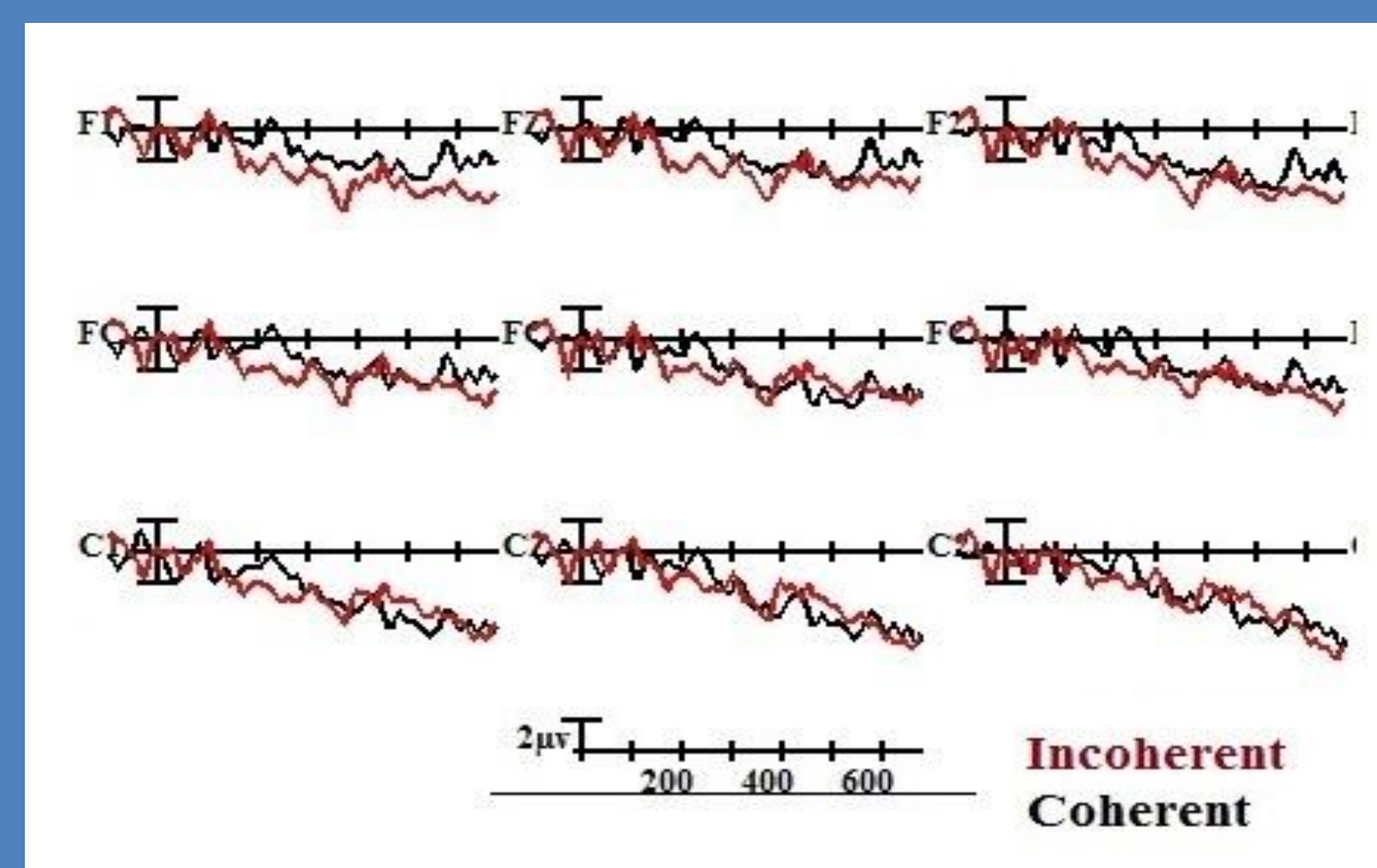
Time-locked to motor response

No effect of Motor Preparation for coherent vs. incoherent trials: ($F < 1$)

No effects in the 3-500 ms time window: ($F < 1$)

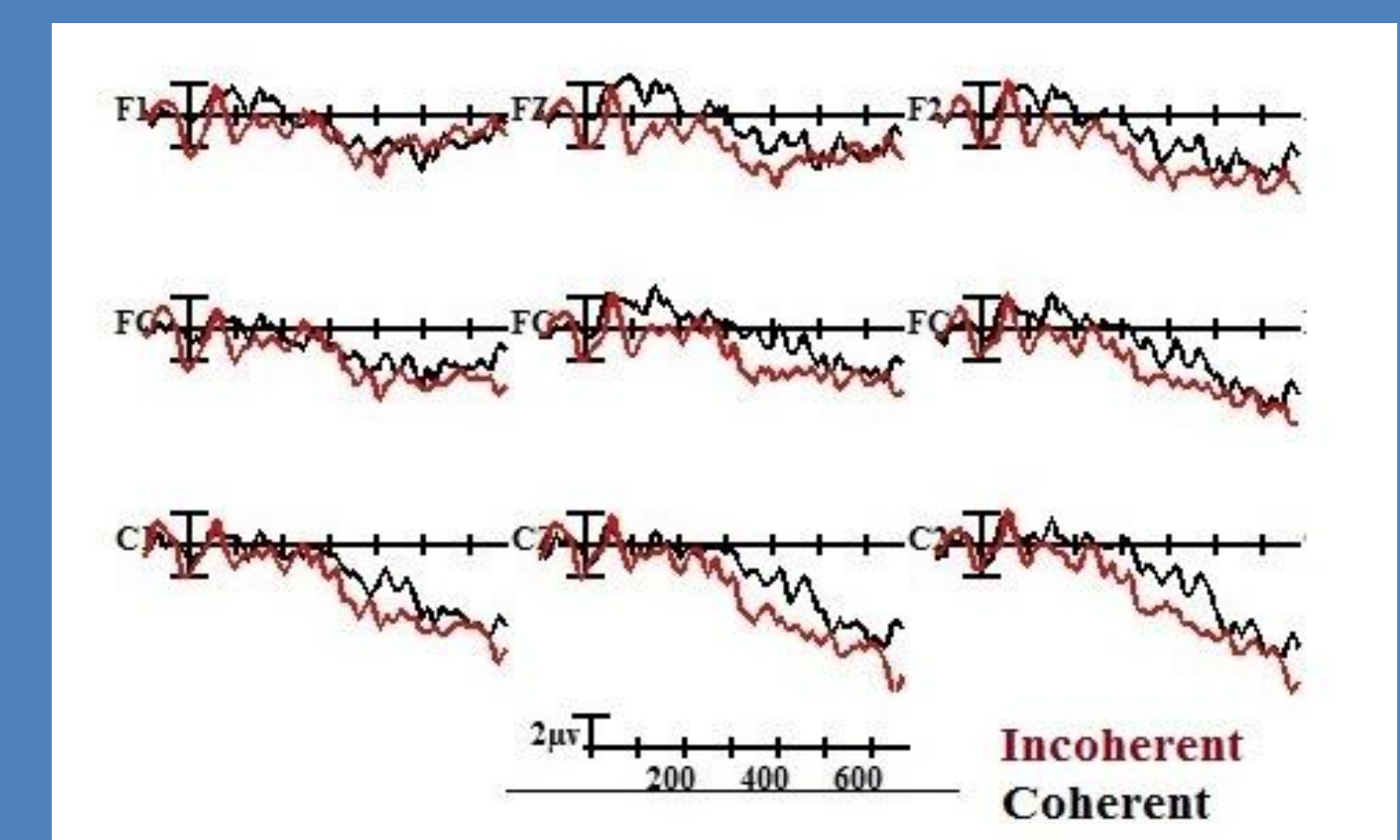


verb onset



Towards Condition:
 No effect of coherency ($F < 1$) in the 300-500 ms time window

Time-locked to critical



Away Condition: significant difference between incoherent vs. coherent trials ($F(1,7) = 5.26$, $p < .05$) in the 300-500 ms time window

CONCLUSION

No clear ACE effect was found

No evidence of variation on Motor Preparation

Semantic processing: effects varied by condition, only for movements towards the body was there a difference between coherent and incoherent trials

When effects are present, they are not strong as a function of direction of movement

This goes against a strong embodied cognition perspective

Next step: Same experiment in first-person perspective