

# Embodied Cognition? Evidence From Hand and Foot Responses to Hand- and Foot-Related Action Words

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Poster # 5004 presented at the 53<sup>rd</sup> annual meeting of the Psychonomics Society, Minneapolis, Nov 2012. Contact: [miller@psy.otago.ac.nz](mailto:miller@psy.otago.ac.nz)

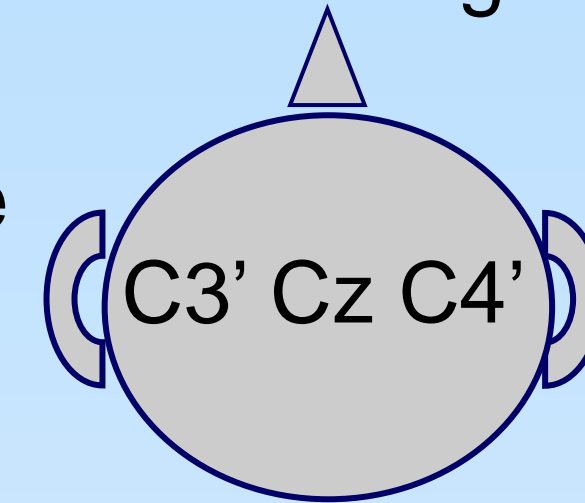
## Overview

According to “embodied cognition” theories of language comprehension, the process of understanding an action word (e.g., *slap*, *kick*) necessarily involves activating the areas of the motor cortex responsible for carrying out the named action (e.g., Gallese & Lakoff, 2005). In this study we tested for three predictable effects of such motor cortex activation during word recognition (one effect in RT, two in EEG). Despite finding strong overall effects of motor activation, we found no evidence for any of the predicted effects of word-based activations, and we conclude that action words can be understood without activation of corresponding areas in motor cortex.

## Experimental Method

16 participants (15 right-handed) performed a lexical decision task (“word” versus “nonword” judgments) with visually presented letter strings. The stimulus words named actions performed with either the hands (e.g., *slap*) or the feet (e.g., *kick*), and nonwords were pronounceable. “Word” responses were right-hand keypresses and “nonword” responses were right-foot pedal presses, or vice versa, as shown in the table of S-R assignments on the right.

Motor cortex activation was assessed with EEG recorded at three electrode sites known to be affected by motor processes associated with hand and foot responses —C3’, Cz, and C4’:



The critical manipulation was whether the words referred to actions *congruent* or *incongruent* with the response hand or foot. According to “embodied cognition” theories, congruent action words should activate the areas of motor cortex involved in responding, and incongruent action words should activate the areas associated with the competing response.

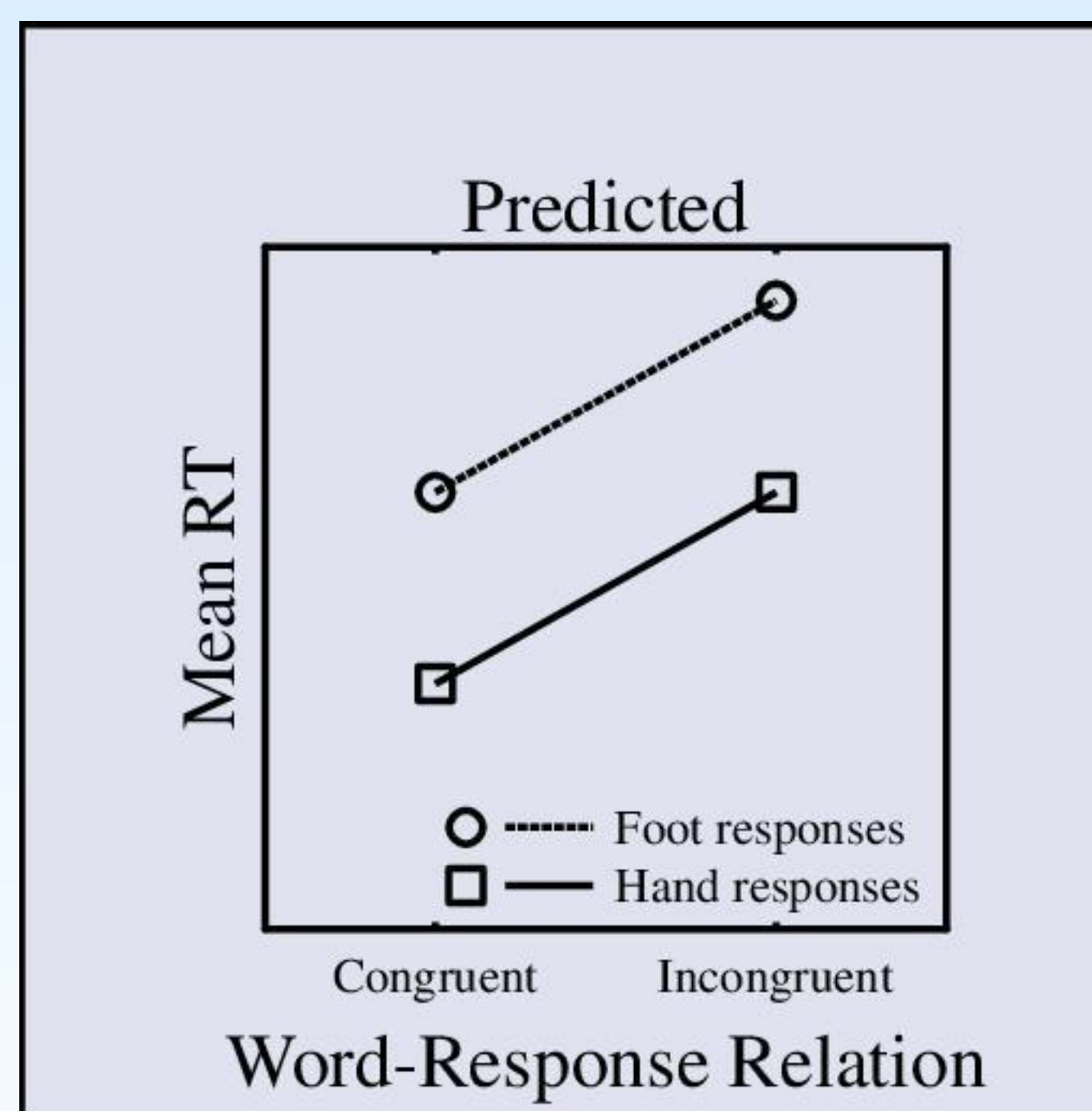
Stimulus-Response Assignments & Word-Response Conditions Counterbalanced Across 2 Groups				
		Word Stimuli		Nonword Stimuli
		Hand-related actions (e.g., “slap”)	Foot-related actions (e.g., “kick”)	
Group 1	Response Assignment	Right hand	Right hand	Right foot*
	Word-Response Relation	<i>Congruent</i>	<i>Incongruent</i>	
Group 2	Response Assignment	Right foot	Right foot	Right hand*
	Word-Response Relation	<i>Incongruent</i>	<i>Congruent</i>	

\*Nonword trials were fillers and results from these trials are not shown.

## References

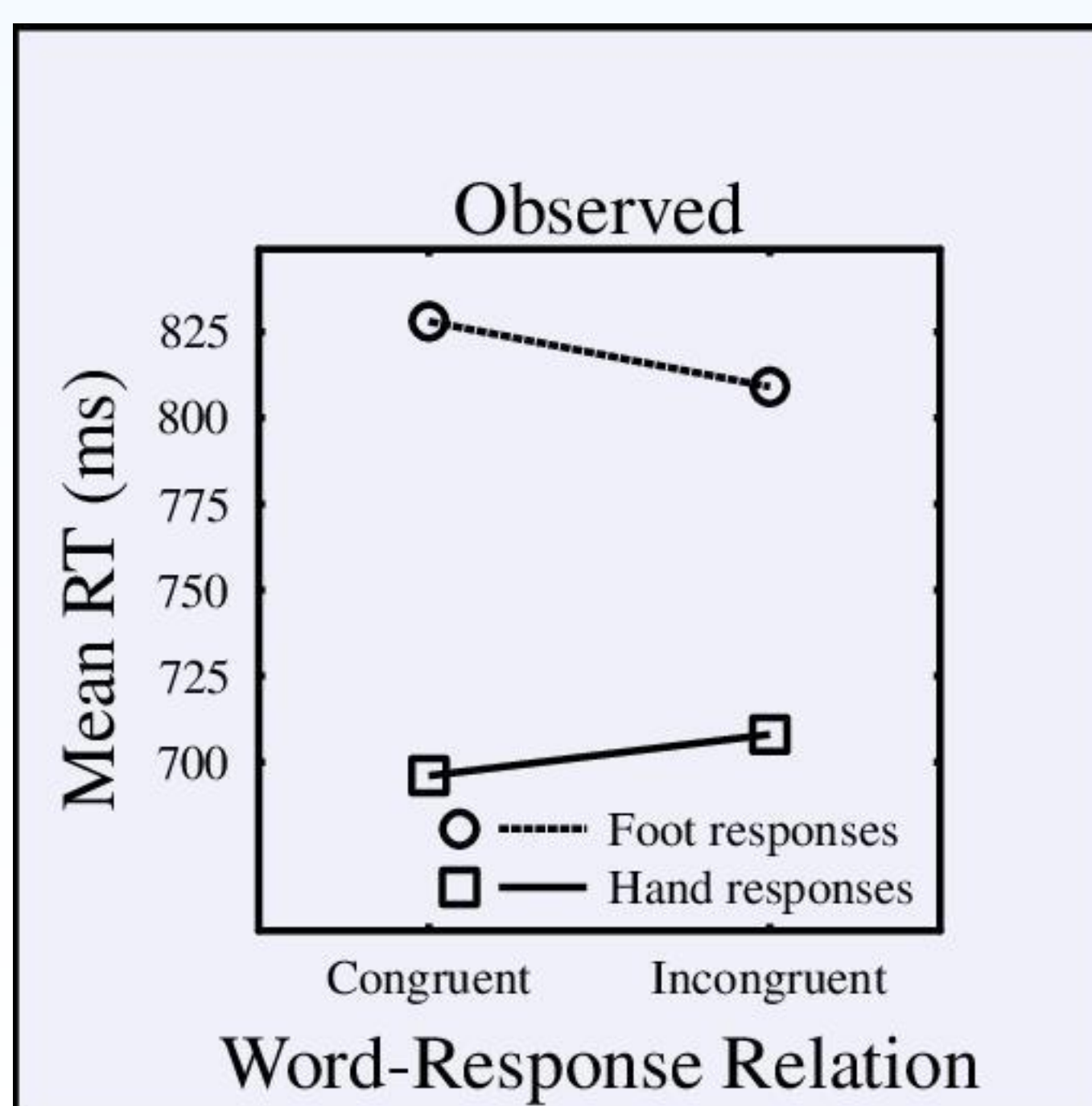
- Brunia, C. H. M. (1980). What is wrong with legs in motor preparation? In H. H. Kornhuber & L. Deecke (Eds.), *Motivation, motor and sensory processes of the brain. Progress in brain research, Vol. 54* (pp. 232-236). Amsterdam: Elsevier.
- Gallese, V. & Lakoff, G. (2005). The brain's concepts: The role of the sensory-motor system in conceptual knowledge. *Cognitive Neuropsychology*, 22 (3-4), 455-479. doi: 10.1080/02643290442000310
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## Prediction 1: Reaction Time



### Embodied Cognition Predicts:

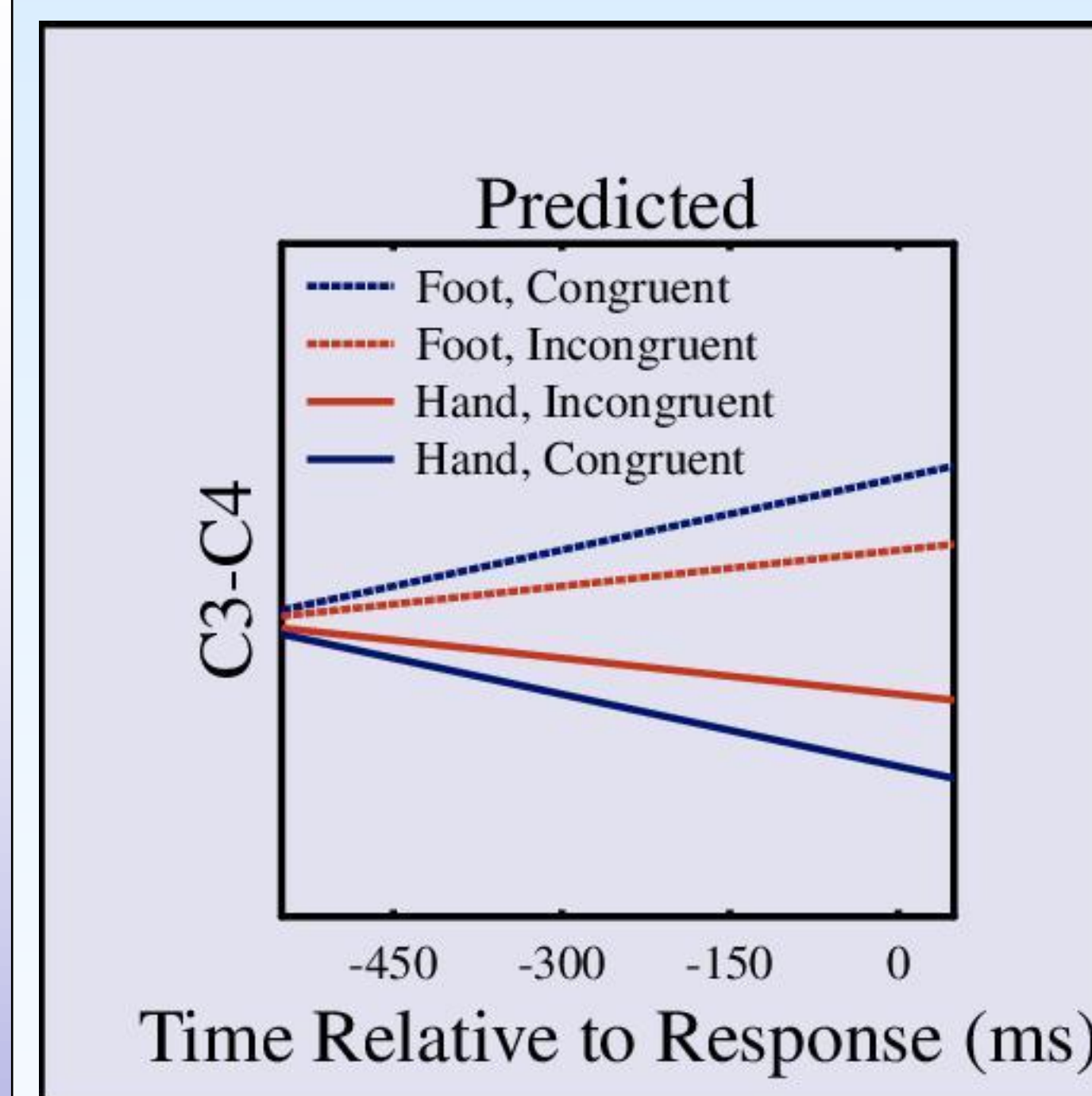
Hand- and foot-related action words should activate the motor areas associated with hand and foot movements. Therefore, responses should be faster when the action word is congruent with the responding effector (e.g., hand response to the word “slap”) than when the word is incongruent (e.g., hand response to the word “kick”).



### Observed Results:

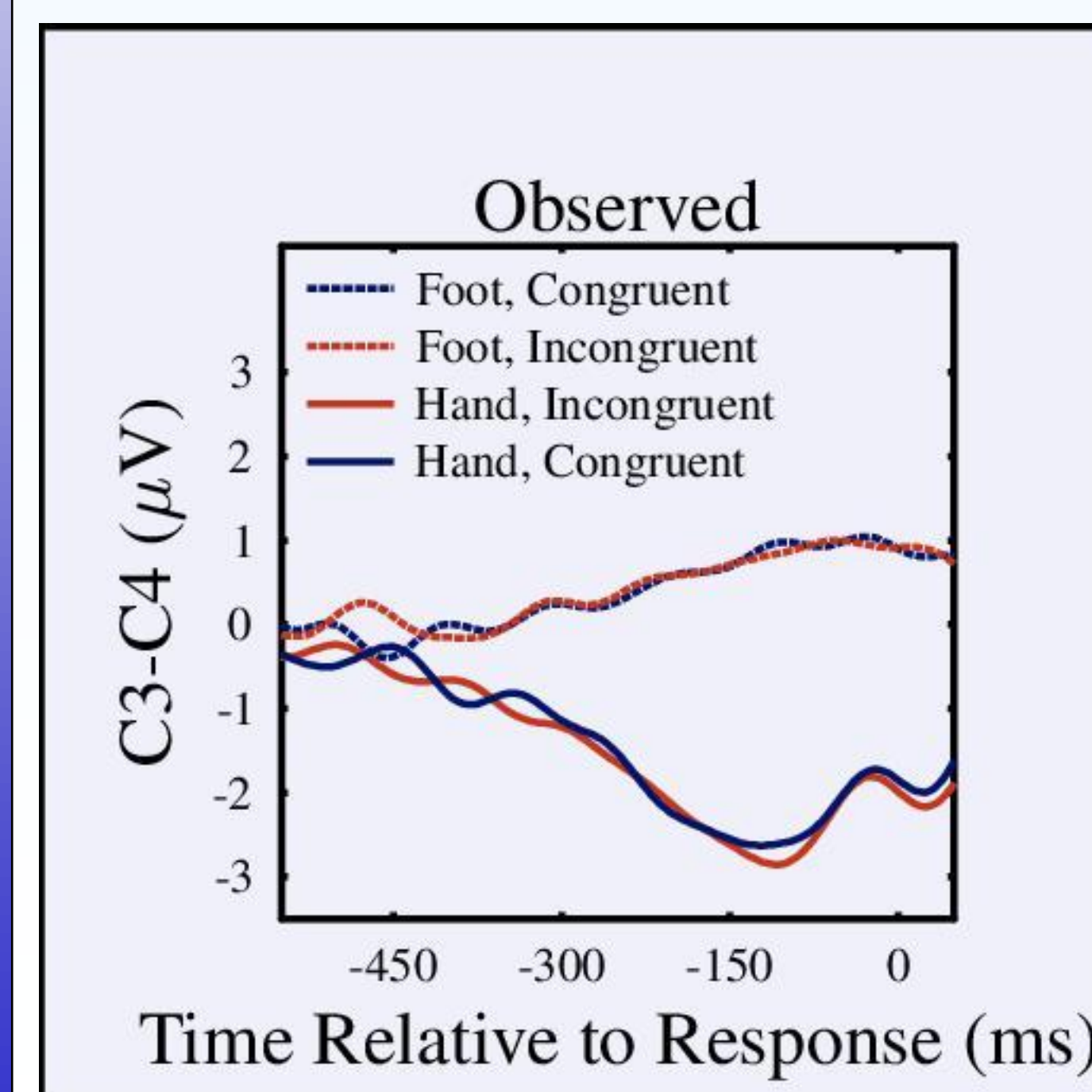
Foot responses were slower than hand responses ( $p < .01$ ). Contrary to the prediction, there was no effect of congruency ( $p > .6$ ). The interaction was significant ( $p < .05$ ), reflecting faster responses to hand-associated words than to foot-associated words.

## Prediction 2: Lateralized Readiness Potential



### Embodied Cognition Predicts:

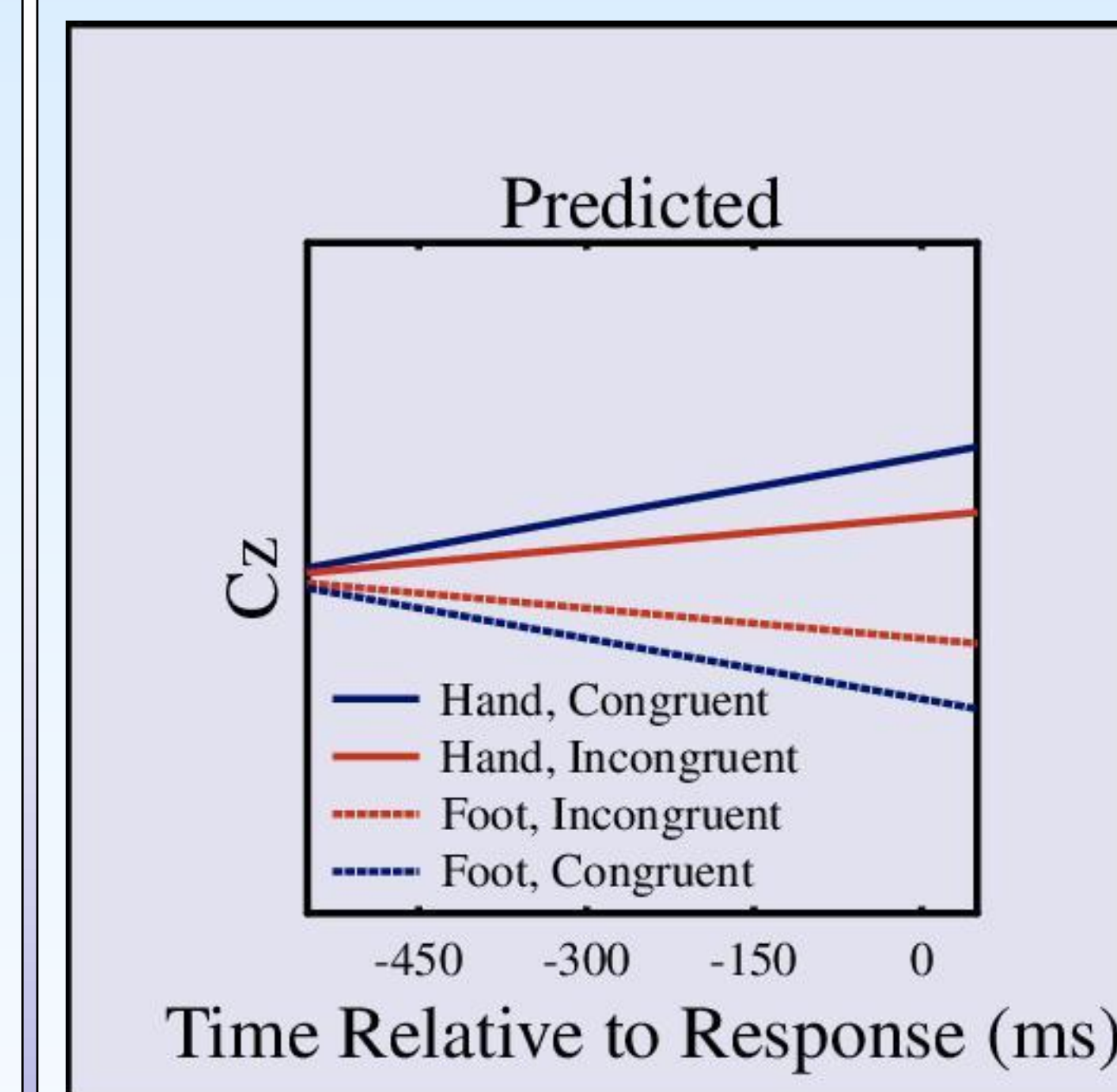
Previous research indicates that right-hand actions result in more negative EEG at C3 than C4, but the reverse is true for right-foot actions (Brunia, 1980). If the motor activations produced during the understanding of action words sum with those produced by actions, lateralized activity should be weakened in incongruent trials relative to congruent trials.



### Observed Results:

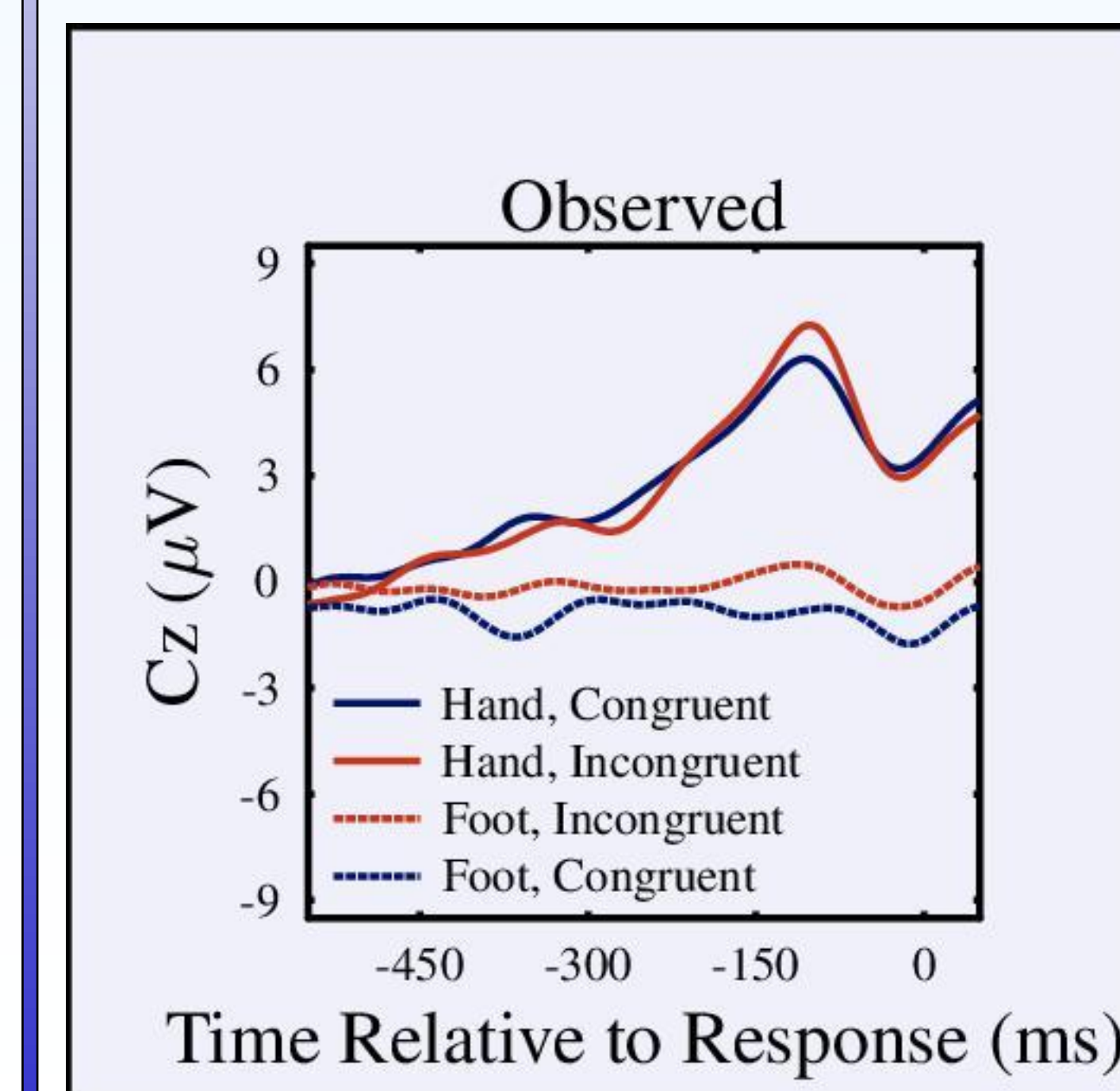
Lateralized motor activity differed for hand versus foot responses ( $p < .001$ ), consistent with previous research. Contrary to the prediction, there was no effect of action word congruence on lateralized EEG activity ( $p > .5$ ).

## Prediction 3: Cz Amplitude



### Embodied Cognition Predicts:

Previous research indicates that hand actions result in more positive EEG at Cz than do foot actions (Miller, 2012). If the motor activations produced during the understanding of action words sum with those produced by actions, Cz activity should be weakened in incongruent trials relative to congruent trials.



### Observed Results:

Cz activity was more positive for hand than foot responses ( $p < .001$ ), consistent with previous research. Contrary to the prediction, there was no effect of action word congruence on Cz activity ( $p > .2$ ).