Embodied Cognition? Effects of Hand- and Foot-related Action Words on Hand and Foot Responses in a Stroop-like Task

Jeff Miller
University of Otago, New Zealand

&

Barbara Kaup
University of Tübingen, Germany

Poster # 5031 presented at the 55th annual meeting of the Psychonomics Society, Long Beach, Nov 2014. Contact: *miller@psy.otago.ac.nz* or *barbara.kaup@uni-tuebingen.de*

Overview

According to "embodied cognition" theories of language comprehension (e.g., Gallese & Lakoff, 2005), 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. In this study we tested for effects of such motor cortical activation on reaction time (RT) and on two motor event-related potential (ERP) components within a Stroop-like task. Stroop congruence had strong effects on RT, but no effect on motor ERPs. We conclude that action words can at least sometimes be understood without any activation of the corresponding areas in motor cortex.

Table 1: Stimulus Combinations, Responses, and Congruence Conditions

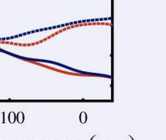
Imperative Stimulus	Stroop-like Stimulus: Hand-related action word (e.g., "*slap*")	Stroop-like Stimulus: Foot-related action word (e.g., "*kick*")	Stroop-like Stimulus: Nonword*
"HAND"	***Hand Response, Congruent***	***Hand Response, Incongruent***	*No-go Response*
"FOOT"	***Foot Response, Incongruent***	***Foot Response, Congruent***	

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

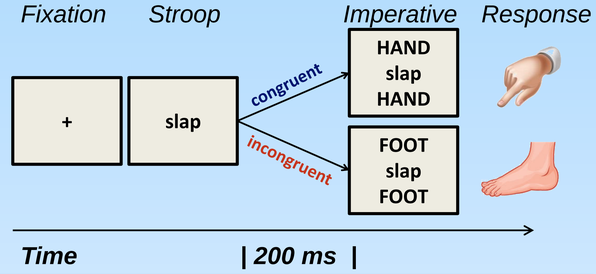
Experimental Method *(differs from program abstract)*

Table 1 summarizes the conditions, and the trial sequence is illustrated in the figure at the right. In each trial the Stroop-like stimulus was a letter string that appeared at fixation. It was either a hand- or foot-related action word (e.g., *slap* or *kick*) or a pronounceable nonword. The imperative stimulus "HAND" or "FOOT" appeared 200 ms later, above and below the Stroop stimulus. Participants were instructed to respond with the hand or foot as indicated by the imperative stimulus when the Stroop stimulus was a word, but they were to withhold the response ("no-go") when it was a nonword.

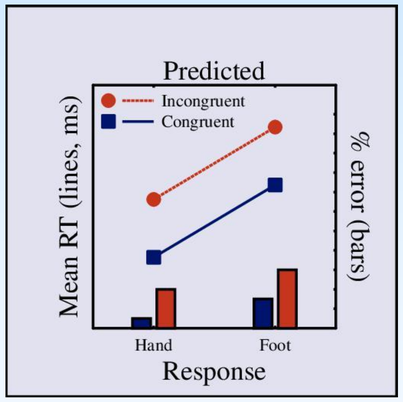
Motor cortex activation was assessed by recording EEG at three electrode sites known to be affected by the motor processes associated with hand and foot responses: C3', Cz, and C4':



Trial sequence (go-trials):

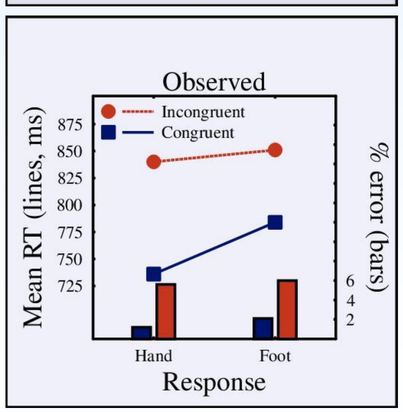


Reaction Times & Error Rates



Embodied Cognition Predicts:

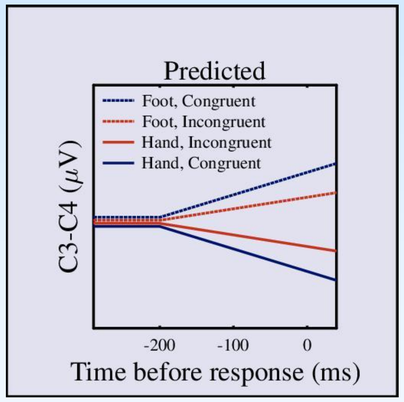
Hand- and foot-related action words should activate the motor areas associated with hand and foot movements. Therefore, responses should be faster and more accurate when the action word is congruent with the responding effector than when the word is incongruent.



Observed Results:

Consistent with the prediction, responses were faster when the Stroop word was congruent rather than incongruent with the response ($p < .001$), and this effect was larger for hand than foot responses (interaction $p < .025$). More errors were also made in incongruent trials ($p<.001$).

ERPs: Lateralized Readiness Potential



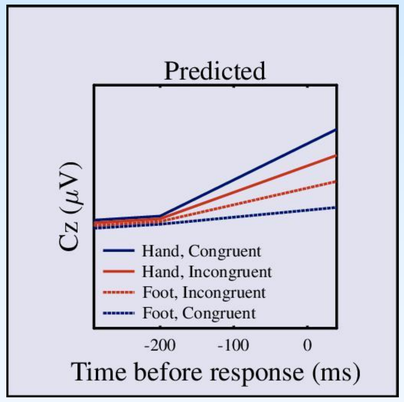
Embodied Cognition Predicts:

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

Observed Results:

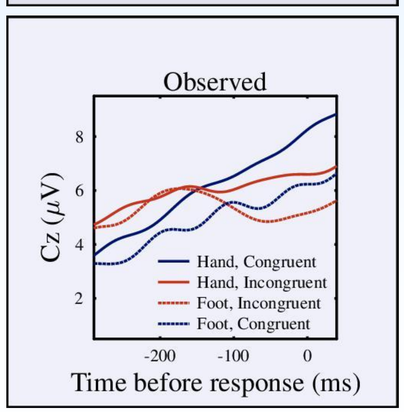
Lateralized motor activity differed for hand versus foot responses ($p <.001$), consistent with previous research. Contrary to the prediction, there was no influence of action word congruence on the lateralized motor activity ($p >.5$).

ERPs: Cz Amplitude



Embodied Cognition Predicts:

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



Observed Results:

Cz activity was more positive for hand than foot responses ($p <.01$), consistent with previous research. Contrary to the prediction, there was no influence of action word congruence on Cz activity ($p >.5$).

→ action word meanings were understood… …but there is no evidence that they activated the motor system! Disembodied cognition?

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. **Miller, J. O. (2012)**. Selection and preparation of hand and foot movements: Cz activity as a marker of limb system preparation. *Psychophysiology, 49 (5),* 590-603.