



Modality switches occur early and extend late in conceptual processing: evidence from ERPs



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Engagement of sensory, motor brain regions during word recognition is well documented. Critical questions:

Functional role OR epiphenomenal processes? Directly compatible with **distributional processing?**

RESEARCH: Reaction time (**Conceptual Modality Switch/CMS** [1]), fMRI (seeing, reading colour in same cortex [2]), ERPs (**CMS** [3, 4]), causality-oriented TMS (hand action understanding in premotor cortex [5]).

CHALLENGE: Throughout the one second of word processing, multiple levels may gradually overlap [6]:



GOALS: Constrain time course of an effect, test distributional and embodied processing via CMS paradigm.

Task: verify the relation of property and concept words. **Covert:** conceptual modality of successive trials.

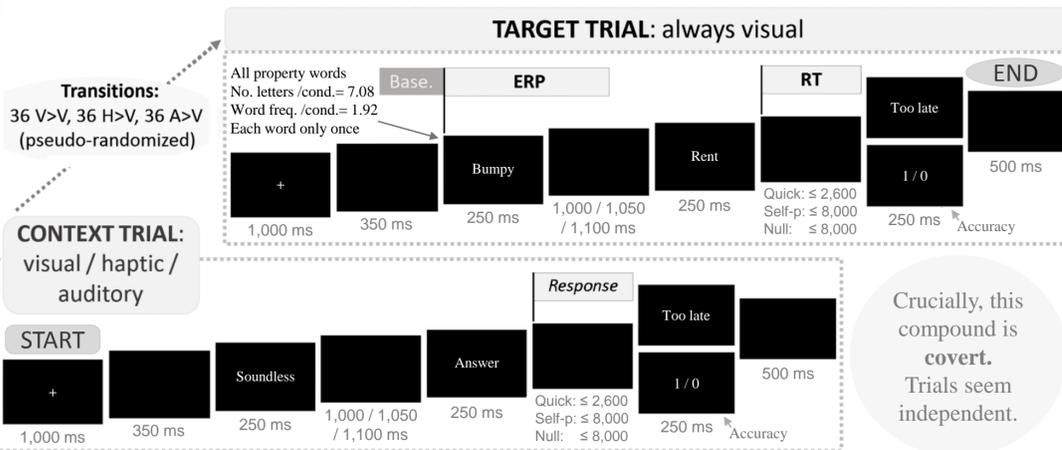
Result: even if orthogonal to the task, **CMS creates a processing cost** that gets picked up in ERPs and RTs.

Previously, **ERPs** were time-locked to last word in trial. **Study [3]:** An iron is hot || **Study [4]:** Candles flicker

✗ Un-controlled first word switch ✗ Lagged switch measurement ✗ Un-controlled relation concept, property

✓✓✓ **Solution:** **Time-lock to first word** in target trial, a property. Design is specific for ERPs, not RTs.

Test symbolic & embodied processing: A Quick-processing group would miss Haptic-to-Visual switch [7].



Stimuli norming [8]: $N = 42$. Rate 0 to 5 the auditory, haptic, visual strength of 747 words

Pretest: $N = 19$. Response accuracy = 63%.

Participants: Removed 1 ptp w/ errors > 50% & 1 ptp due to too noisy ERPs.

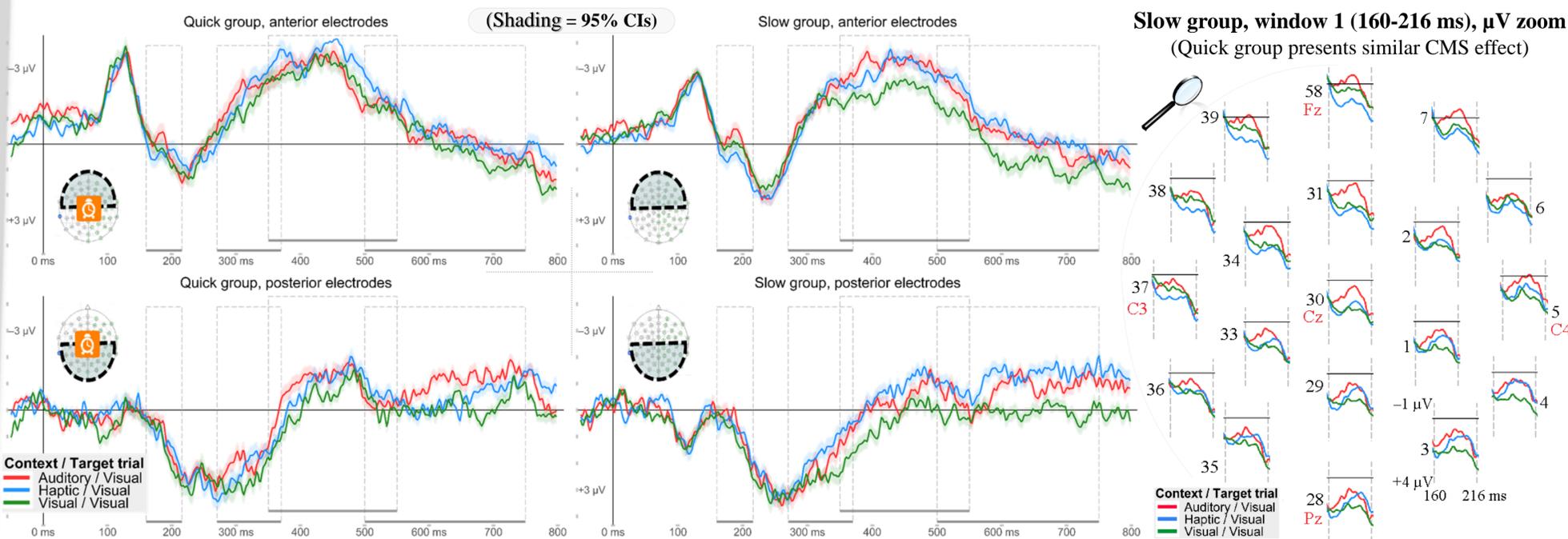
Groups were pooled & re-split: bit.ly/modswitch

Final $N = 23$ Quick, 23 Slow. 37 ♀. Age=22.

Response accuracy: $M = 63%$, $SD = 48$ pp.

Valid preprocessed: 78% ERPs, 99% RTs.

RESULTS: CMS effect—negativity—appears broadly with both switch conditions, esp. in Slow Group & in Posterior area. Effect emerges in w1, then increases (final LME models' $R^2 = .748 - .862$), which converges with compatibility findings [7]. Group & CMS interact in w1 & w2. Interaction later as predicted, yet $p > .05$.



Main results per window. *** $p < .001$; ** $p < .01$; * $p < .05$

Window	Factors	Effect: χ^2
1	CMS	1.40
	CMS x Anterior/Posterior area	48.59***
	CMS x Ant/Pos area x Group	23.63**
2	CMS	6.40*
	CMS x Anterior/Posterior area	10.89**
3	CMS	9.47**
	CMS x Ant/Pos area x Group	4.13***
4	CMS	7.58*

CONCLUSION: CMS effect emerged in the first time window of word processing, providing further support for the role of perceptual simulation in conceptual processing (cf. [9, 10]). An increased CMS effect further in the time course suggests that distributional and embodied processes may be compatible (cf. [7]). More fundamental research on the time course of word comprehension may be beneficial.

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