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:

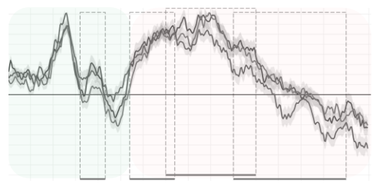
Functional role **OR epiphenomenal** processes**?** Directly compatible with **distributional** processing**?**

RESEARCH: Behaviour (**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: In word timecourse, late simulation effects might be epiphenomenal to comprehension [6]:

~ 160 – 270 ms post word onset:

Lexical, semantic processing



~ 270 ms – 800 ms post word onset:

Lexical, semantic, imagery, episodic memory

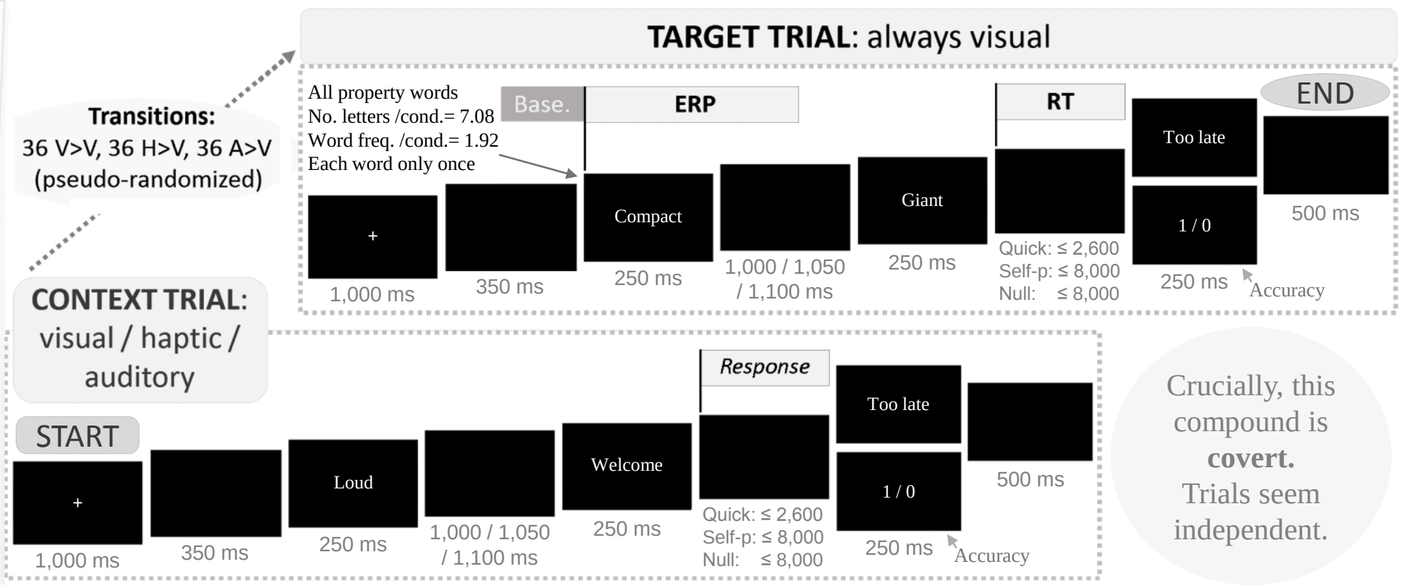
GOALS: Constrain time course of an effect, test distributional and embodied processing via CMS paradigm

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 compatible systems via Groups: Quick group would miss **haptic-to-visual shift**. Slow g would not [7].



Crucially, this compound is **covert.** Trials seem independent.

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

Pretest: *N* = 19. Response accuracy > 50%.

Participants (final): Groups pooled, re-split:
ERP *N* = 23 Quick, 23 Slow. 37 ♀. Age=22.

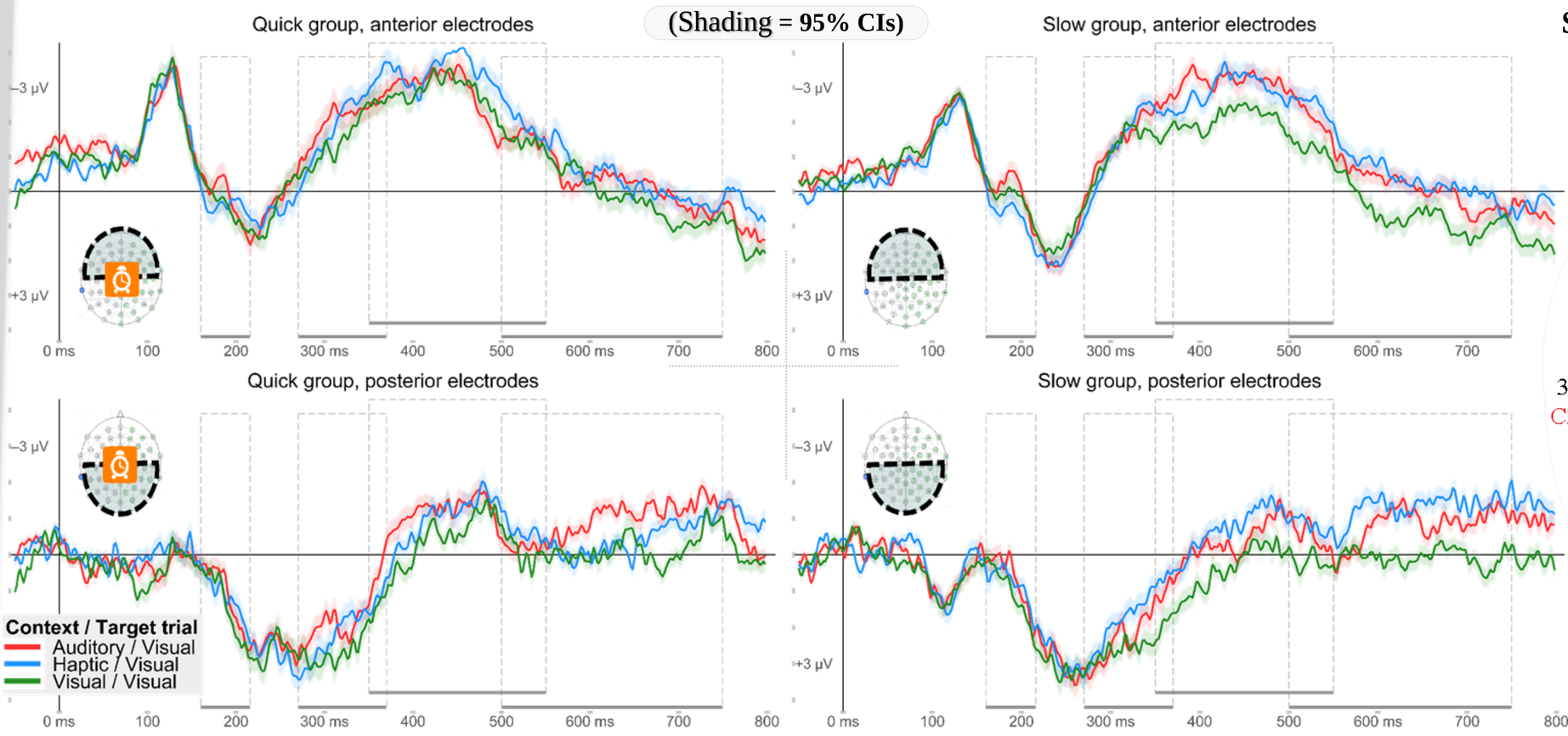
Removed: 1 ptp w/ errors > 50%, 1 ptp due to poor EEG signal.

Poster & all data: bit.ly/modswitch

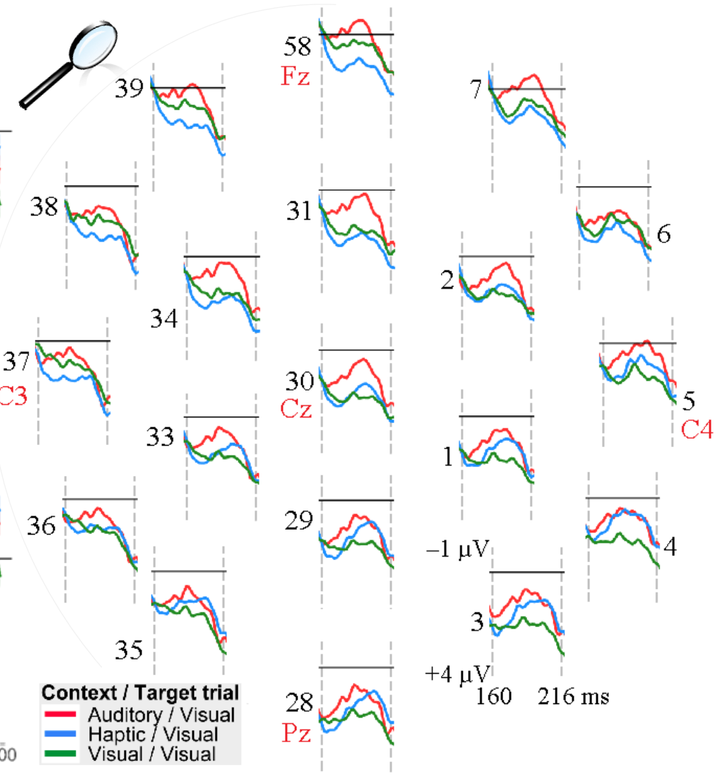
Accuracy (*N* = 47): *M* = 63%, *SD* = 49 pp.

Valid preprocessed: 78% ERPs, 99% RTs.

RESULTS: **CMS effect—negativity**—appears broadly with both switch conditions, esp. in Slow Group & in Posterior areas. Effect emerges in w1, then increases (final LME models' R^2 = .748 – .862). Group & CMS interact in w1 & w2. Interaction later on as predicted, though non-significant. No CMS in RTs (*!* ERP design).



Slow group, window 1 (160-216 ms), µV zoom
(CMS effect in Quick group only slightly smaller)



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^{**}
	CMS x Ant/Pos area x Group	4.13^{***}
3	CMS	9.47^{**}
4	CMS	7.58^{*}

CONCLUSION: CMS effect emerged at the core of lexico-semantic processing, providing further support for the role of sensory brain regions in conceptual processing (cf. [9, 10]). Further, an increased CMS effect later 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 benefitial.

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