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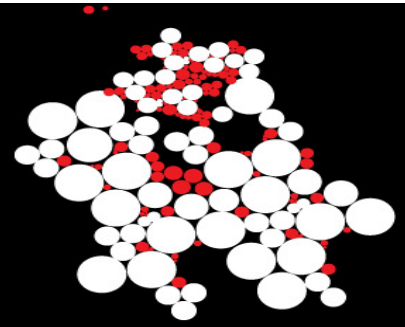
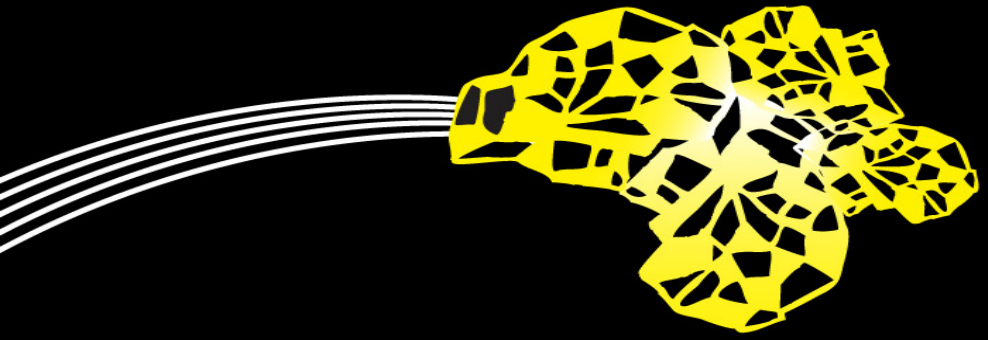
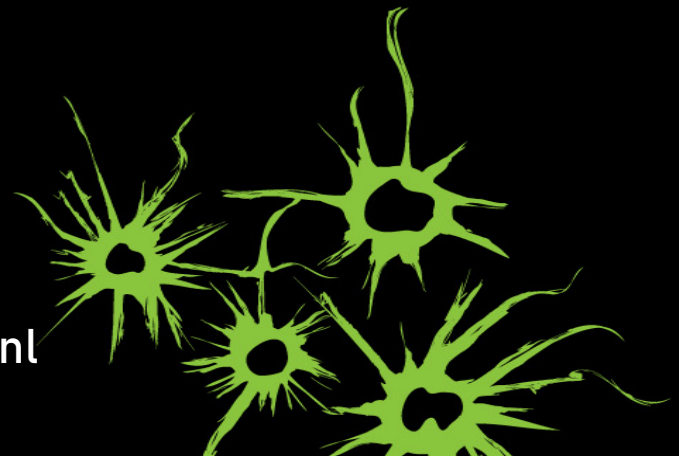


Oscillations & Affordance Competition





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8-12-2023

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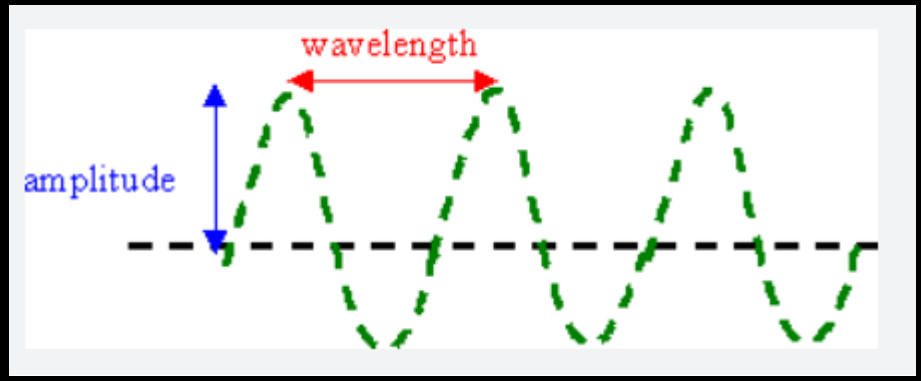
Why a talk about Affordances and Oscillations ?

- Data collection and analyses is biased … , the instruments used to select data are based on (often) implicit theoretical assumptions
- Data alone don't speak, we interpret them, based on often hidden theoretical assumptions
- Affordances " … of the environment are what it offers the animal, what it provides or furnishes …" Gibson (1979, 2015, p. 119)
- Oscillations: regular brain rhythms mostly varying from 0.1 Hz to 100 Hz



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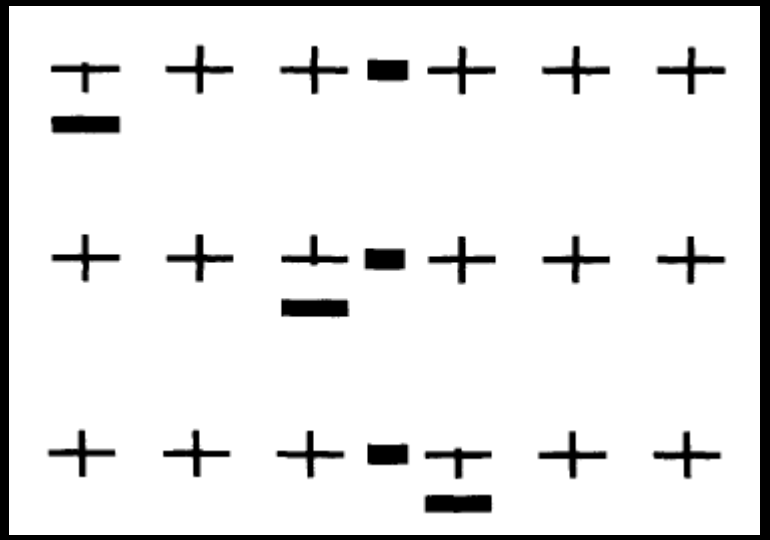
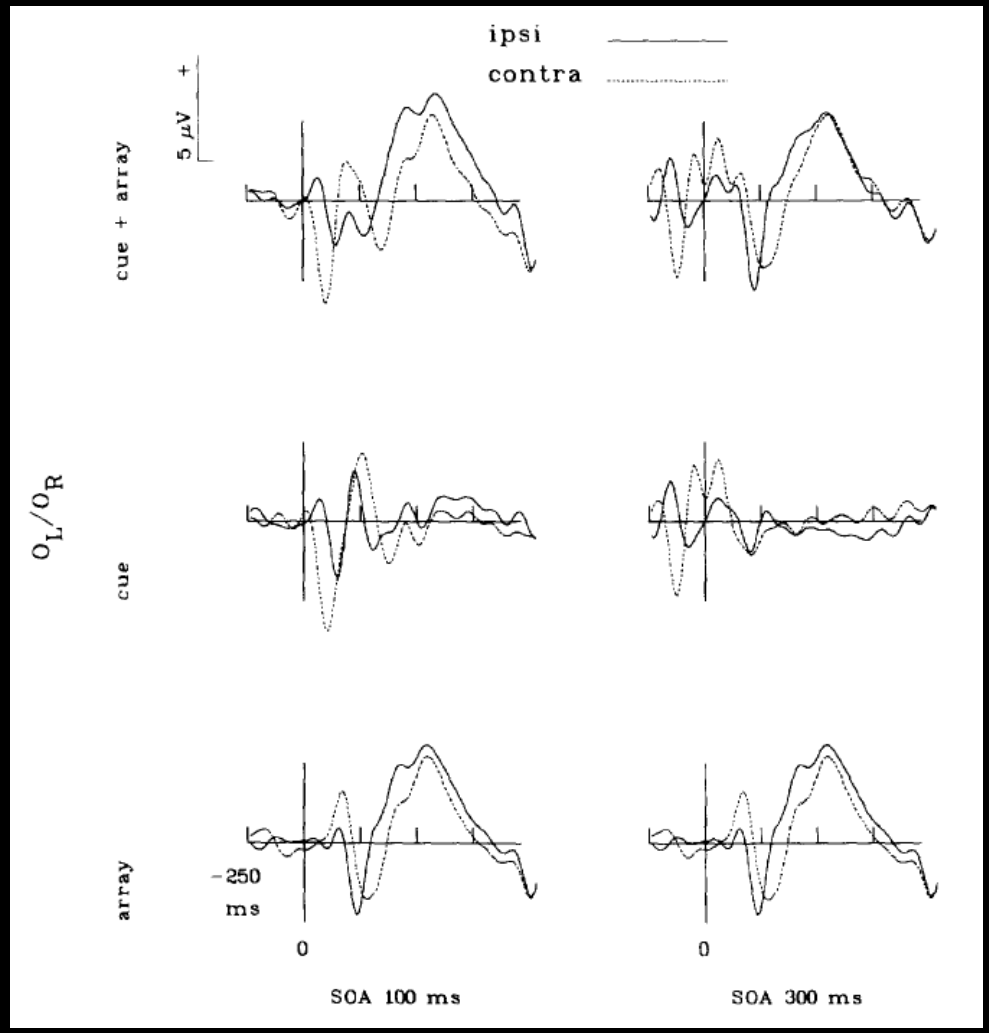
How I started … (Van der Lubbe & Woestenburg, 1997)





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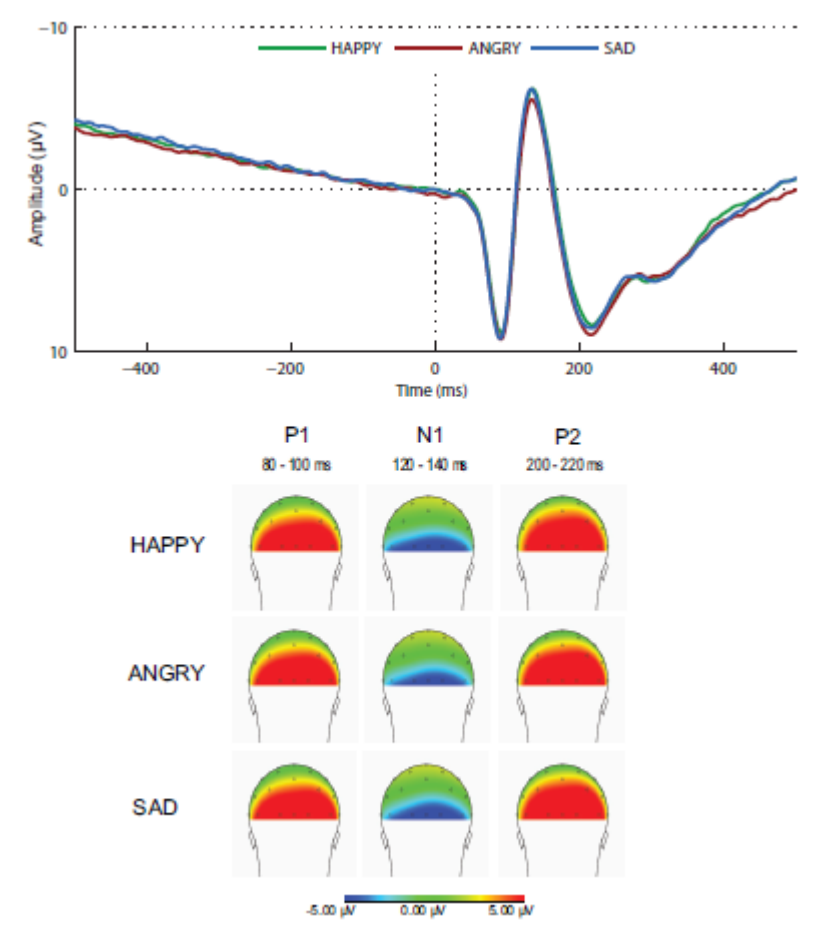
The standard / classical view

In her review paper, Carrasco (2011; p.1484) mentioned: "Each time we open our eyes we are confronted with an overwhelming amount of information. Despite this, we experience a seemingly effortless understanding of our visual world. This requires separating the wheat from the chaff, selecting relevant information out of irrelevant noise. Attention is the key to this process; it is the mechanism that turns looking into seeing. In perception, ignoring irrelevant information is what makes it possible for us to attend to and interpret the important parts of what we see."

Confusion … (Van der Lubbe et al., 2016)



Block window	variable	Happy EP (s.e.)	Happy c_i (s.e.)	Angry EP (s.e.)	Angry c_i (s.e.)	Sad EP (s.e.)	Sad c_i (s.e.)
80-100 ms	ERP	8.3 (0.6)		8.6 (0.6)		8.6 (0.6)	
P1	constant		-5.9* (2.0)		-6.3** (1.5)		-5.7* (1.9)
	θ_1	1.57 (0.06)	-2.7** (0.8)	1.55 (0.06)	-3.7** (0.6)	1.60 (0.05)	-5.3** (0.9)
	θ_2	1.82 (0.05)		1.81 (0.05)		1.82 (0.06)	
	θ_3	2.07 (0.05)		2.05 (0.05)		2.10 (0.05)	
	α_1	2.15 (0.04)		2.13 (0.04)		2.18 (0.04)	
	α_2	2.02 (0.04)	9.2** (1.0)	2.00 (0.04)	10.3** (0.8)	2.02 (0.05)	11.2** (1.0)
	β_1	1.74 (0.04)		1.70 (0.05)		1.76 (0.04)	
	β_2	1.29 (0.05)		1.24 (0.05)		1.34 (0.05)	

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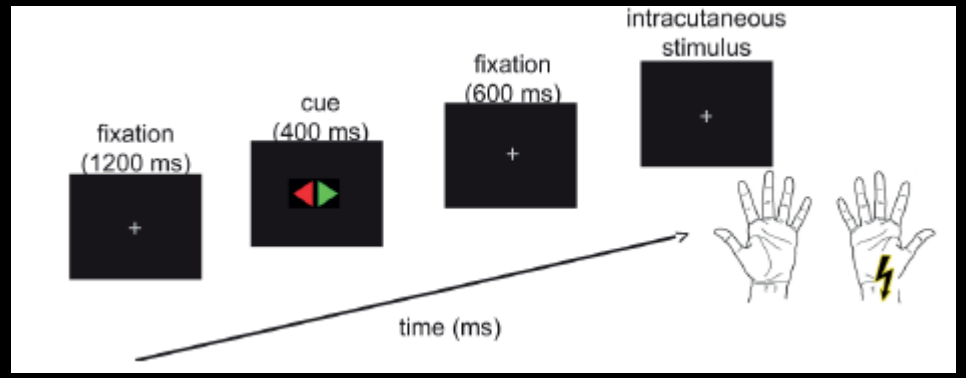
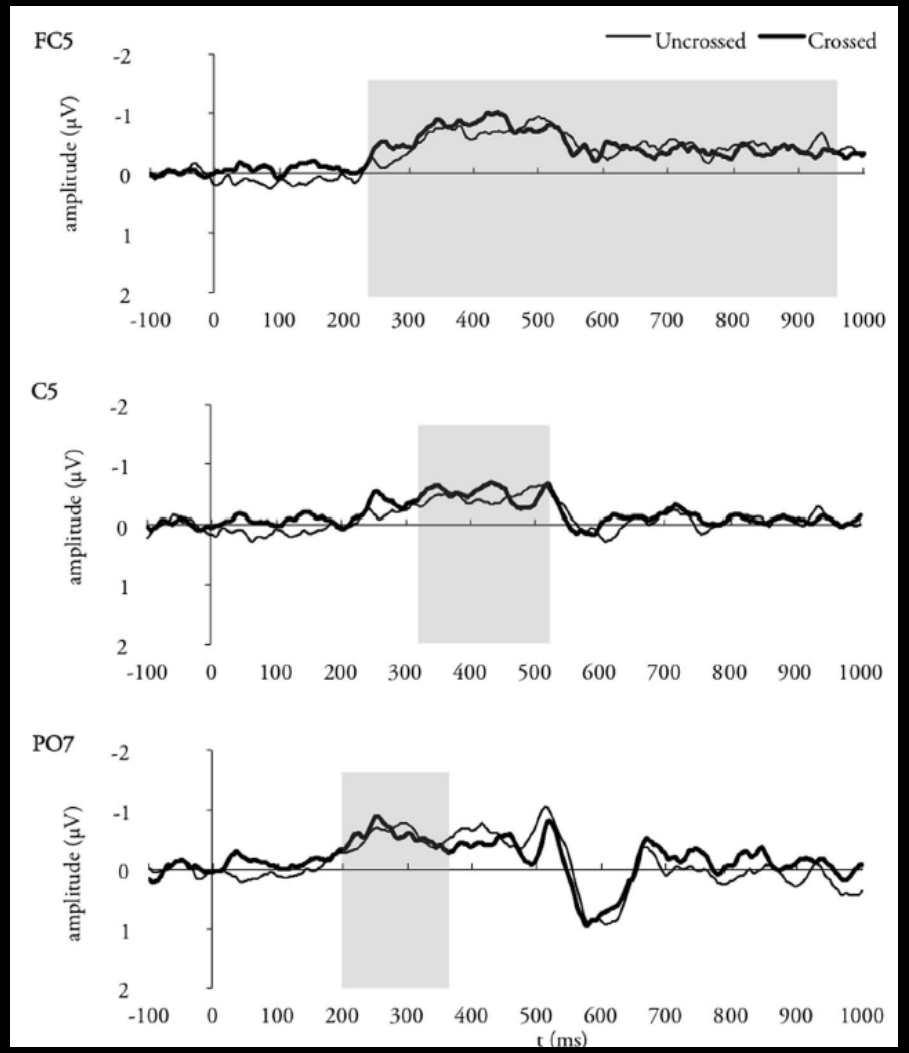
Attending to one's hands in normal and crossed hands conditions (Blom & Van der Lubbe, 2017)





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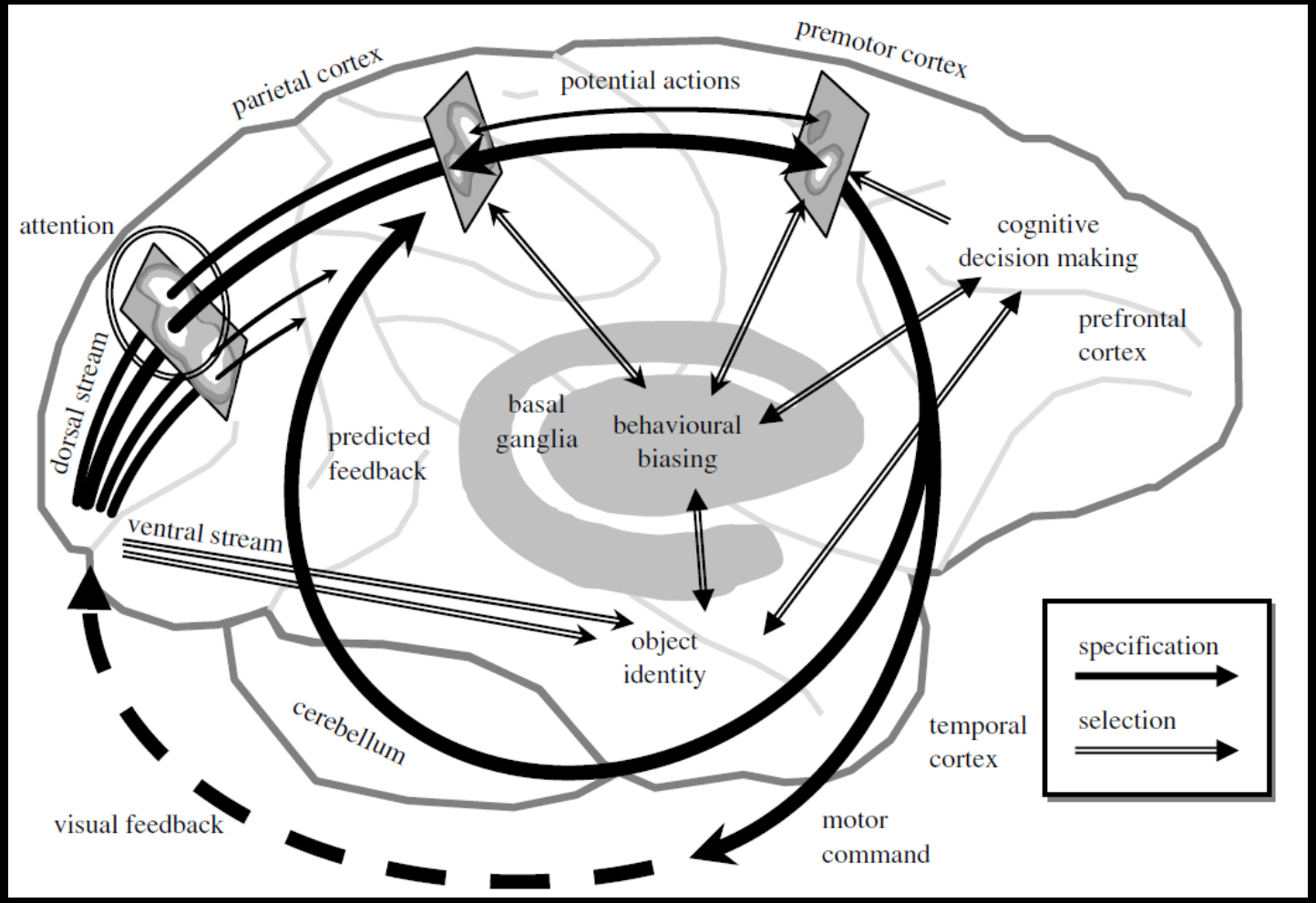
The Affordance Competition Hypothesis Cisek (2007)



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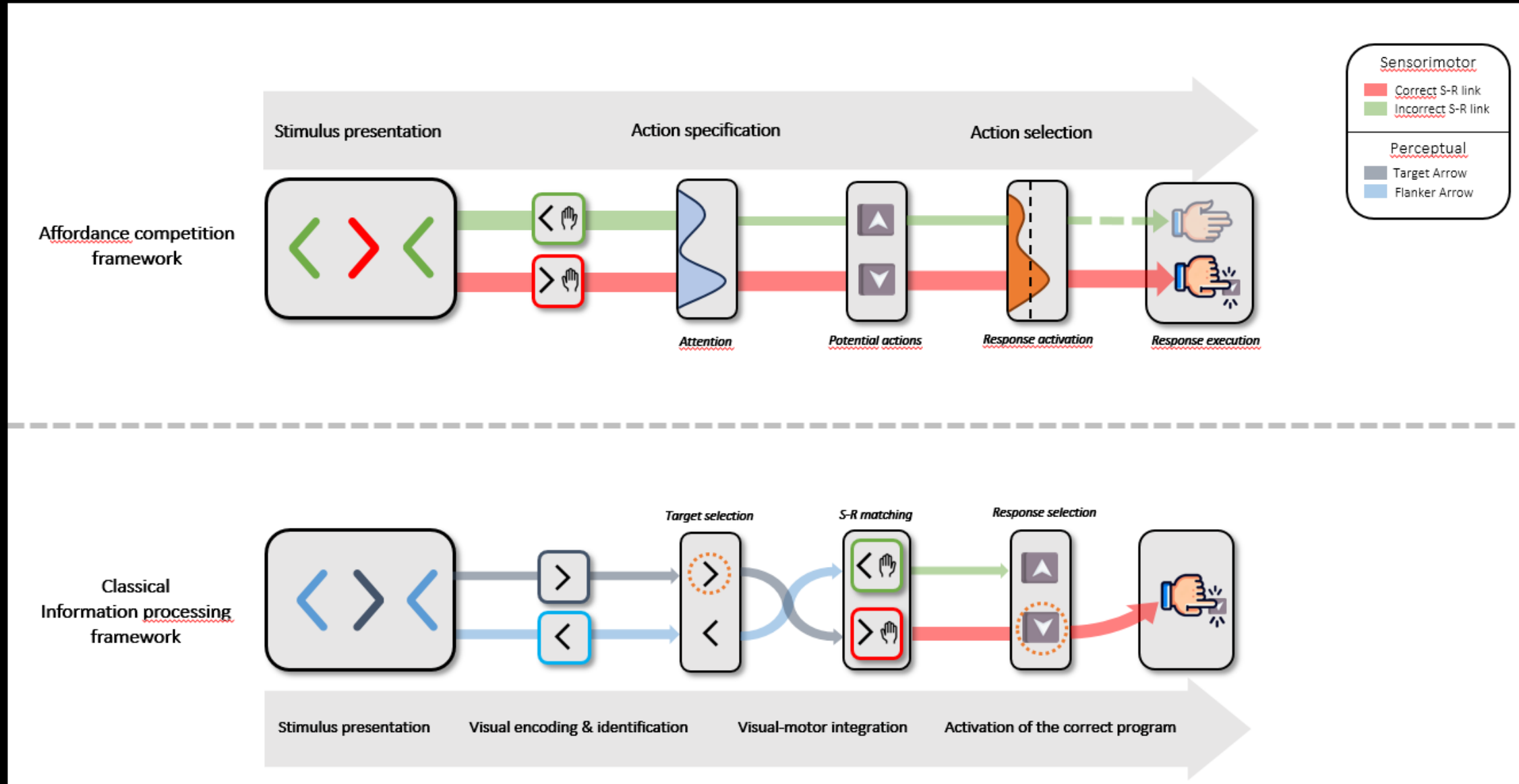

Figure created by Bartłomiej Panek

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Classical View; Relevant Processes

- Perception
- Identification
- Response selection
- Response execution
- Attention serves the role of facilitating perception and thereby selecting proper actions

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Two classes of processes according to Affordance Competition

- Action Specification (driven by the presented or anticipated stimuli), which might especially concern different dorsal routes.

- Action Selection (driven by instructions, biases, etc.), which start with ventral routes, and reroutes from frontal areas.

- Attention biases / guides / or even equals Action Selection

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Affordance: “the *inviting* quality of a percept or event”
(Gibson, 1979)

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What may be meant with the term action?

One might use the term “action” in a very broad sense as “… output from the brain that not only affects skeletal muscles but also exerts autonomic effects (e.g., change heart rate) and control endocrine function … Furthermore, thought and imagination can also be conceived as actions …” (see Buzsáki, 2019; p. 54-55).

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Affordances can be viewed as learned behaviors triggered by specific stimuli

- Affordances are not limited to cups, keys, doorknobs, or chairs
- Affordances will also be acquired during experimental sessions
- Robots also need to learn affordances
- Affordances are crucial for design

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Hierarchical Affordance Competition (Pezzulo & Cisek, 2016)

- Competition can take place between different levels, e.g., long term goals vs. short term goals, which are driven by different biasing centers.
- Frontal brain areas may not be the general decision or control centers; more abstract decisions are biased by these areas, while more concrete decisions are biased by for example parietal areas (e.g., directly along the dorsal pathways).

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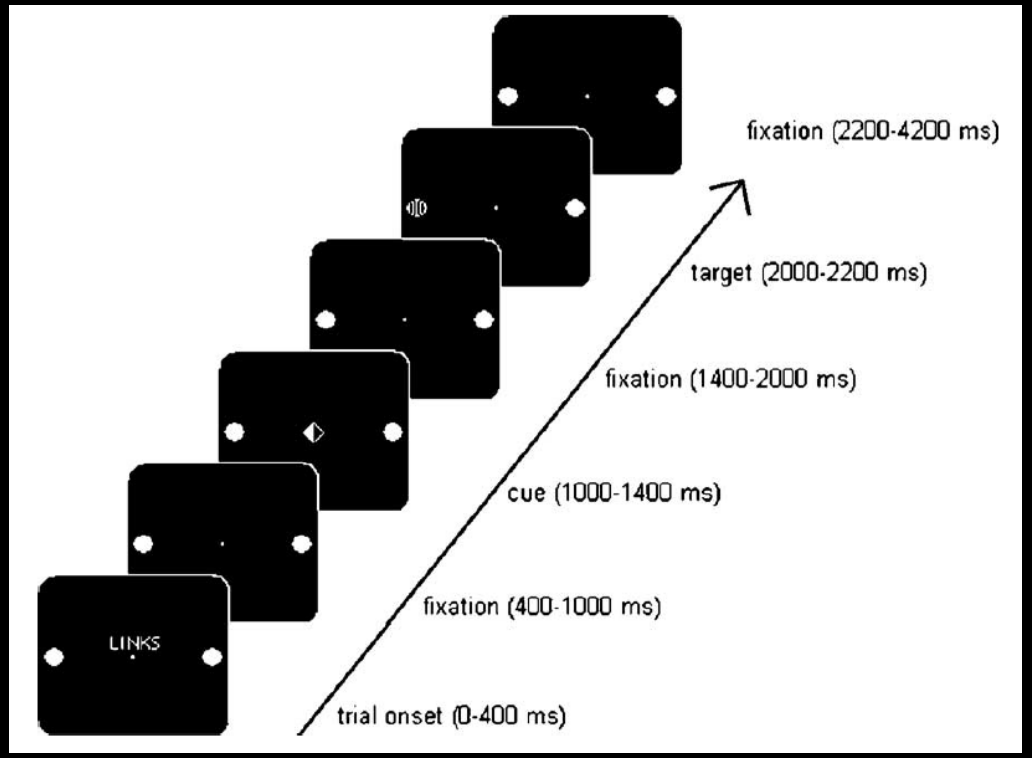
Implications for Interpreting Cortical Oscillations: Attentional Orienting Effects Reflected in Connectivity Patterns in the Alpha band

(Van der Lubbe, unpublished)



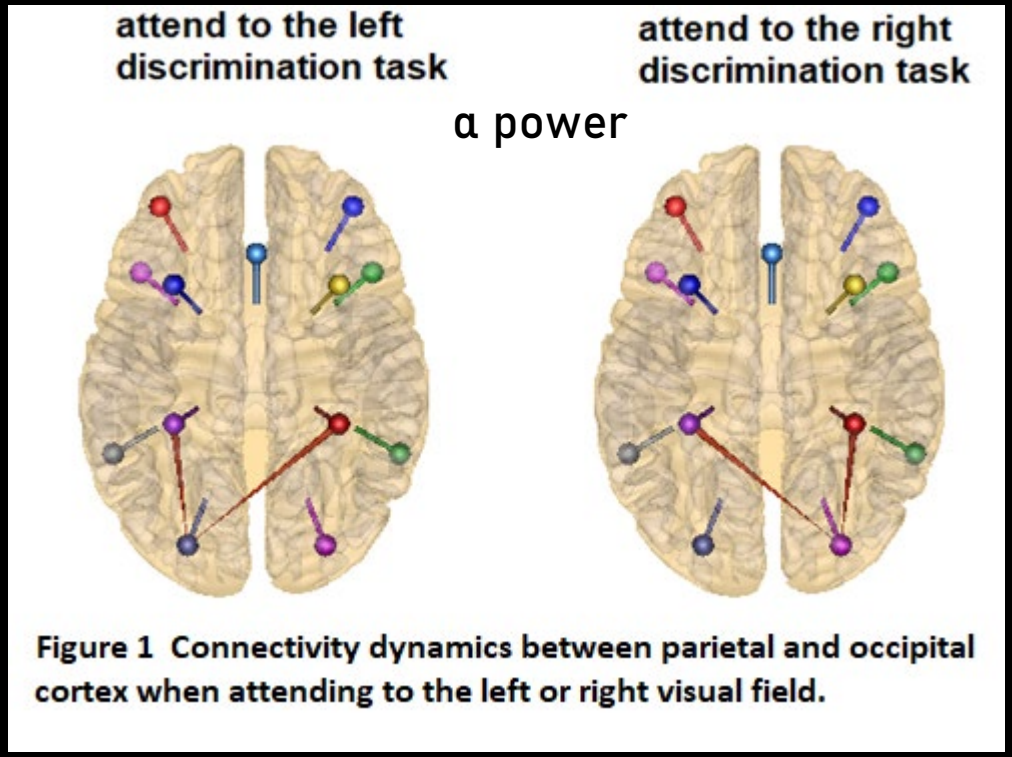


Figure 1 Connectivity dynamics between parietal and occipital cortex when attending to the left or right visual field.

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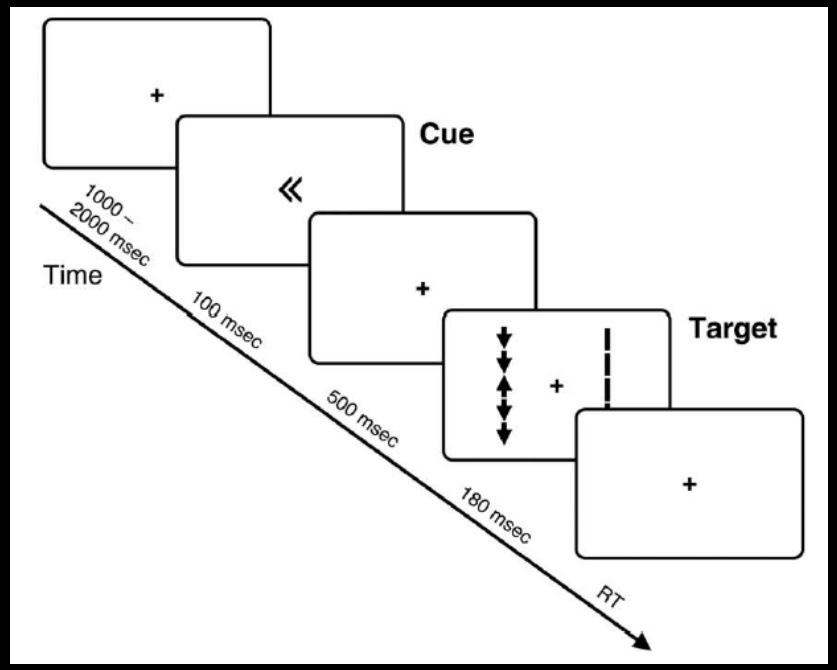
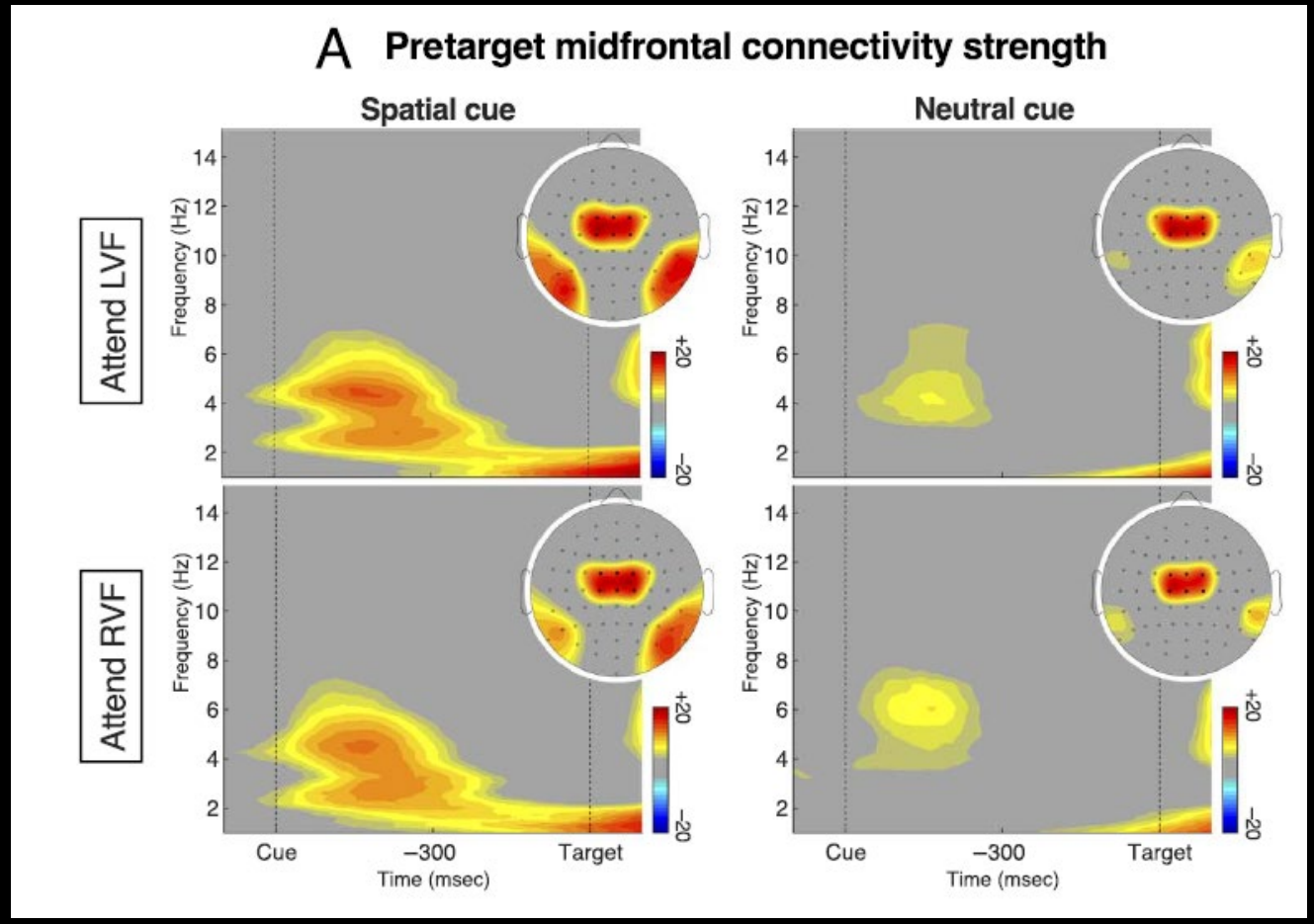
Attentional Orienting Effects Reflected in Connectivity Patterns in the Theta band

Asanowicz et al. (2023)





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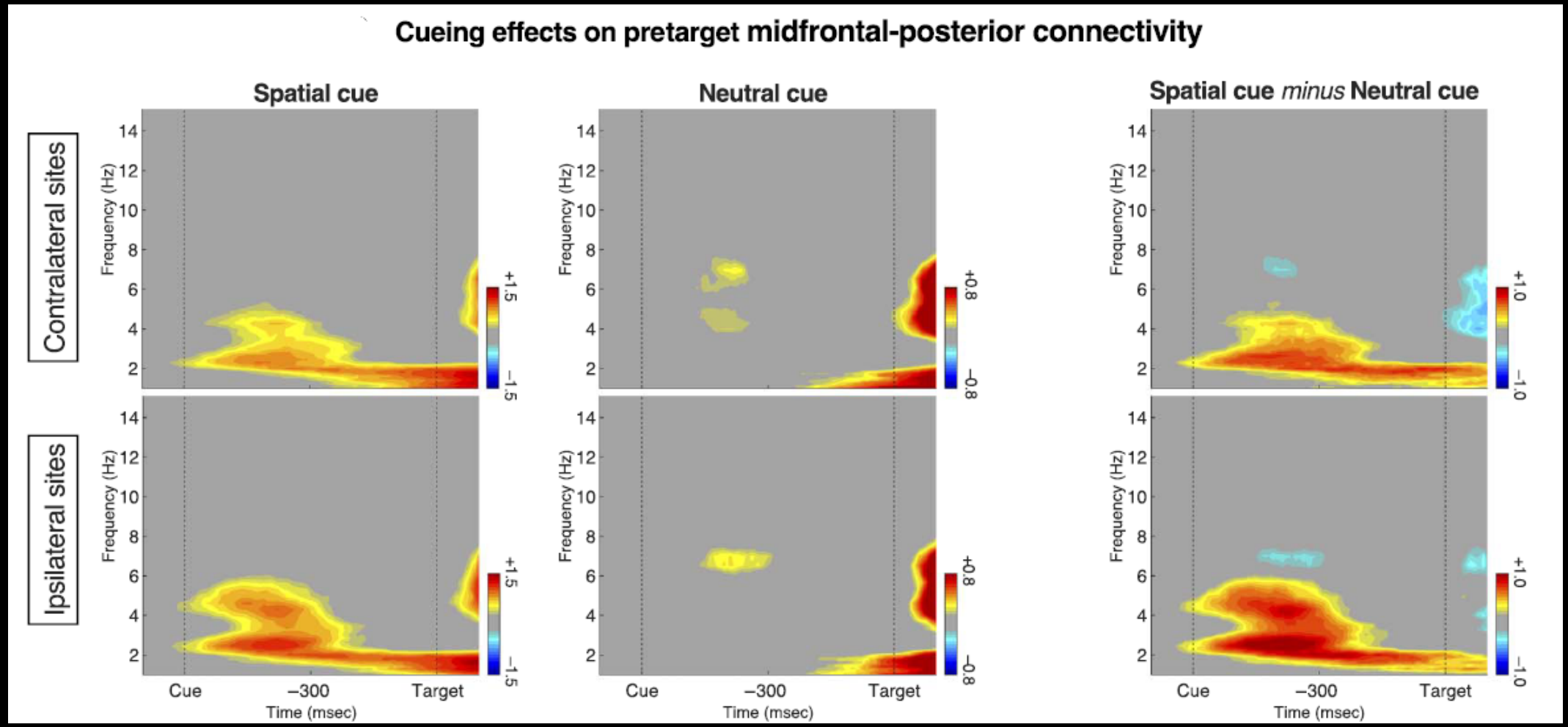
Attentional Orienting Effects
Reflected in Connectivity Patterns in the Theta band
Asanowicz et al. (2023)



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Attentional Orienting & Affordance Competition

Both connectivity patterns may reflect the biasing influence of Action Selection by disfavoring actions related to the ipsilateral visual field.

Alpha connectivity between Occipital and Parietal Cortex may reflect competition that is dominated by a spatial level.

Theta connectivity between Occipital and Medial-Frontal Cortex may reflect competition that includes a more abstract level to enable the selection of the proper action as more interference is anticipated.

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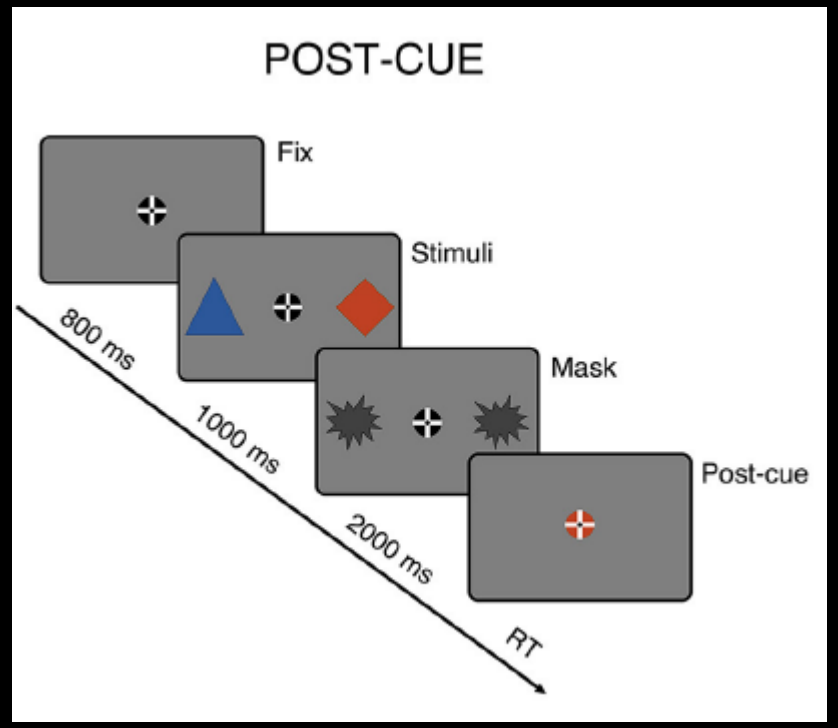
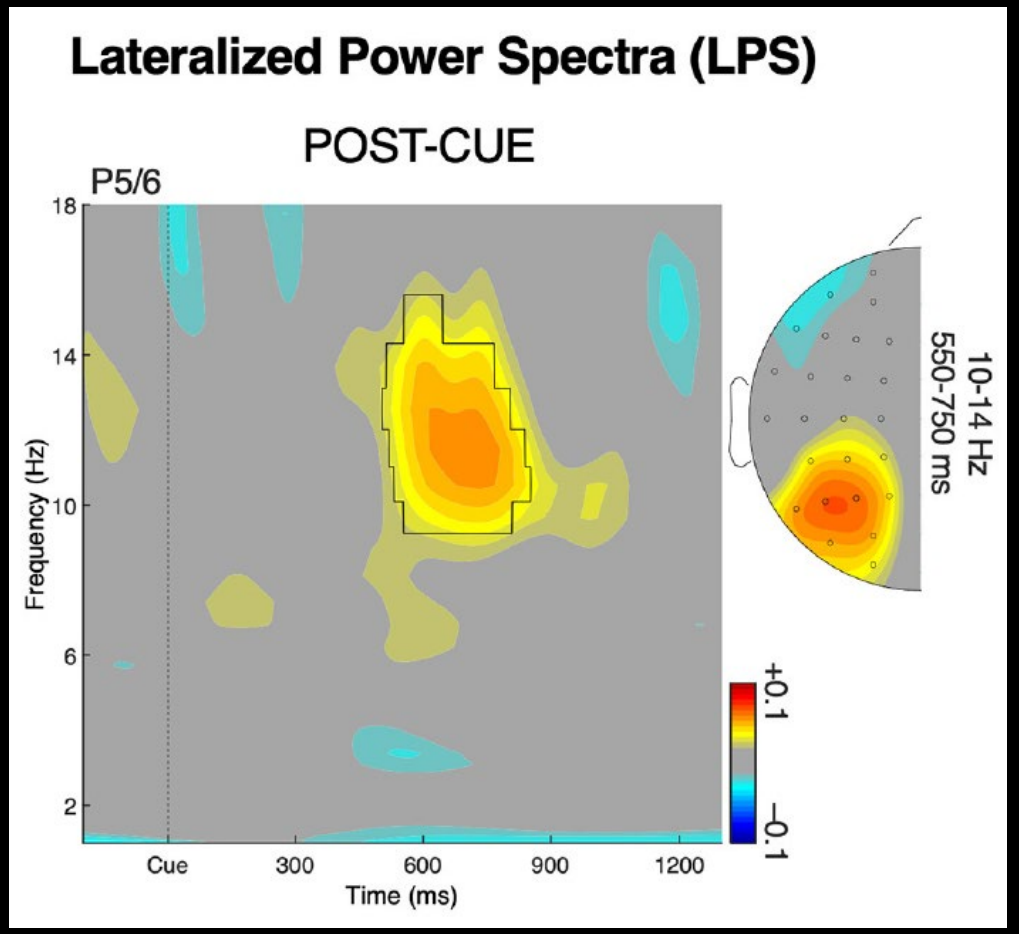
Implications for Interpreting Cortical Oscillations: Retrieval from Memory (Van der Lubbe et al., 2023)





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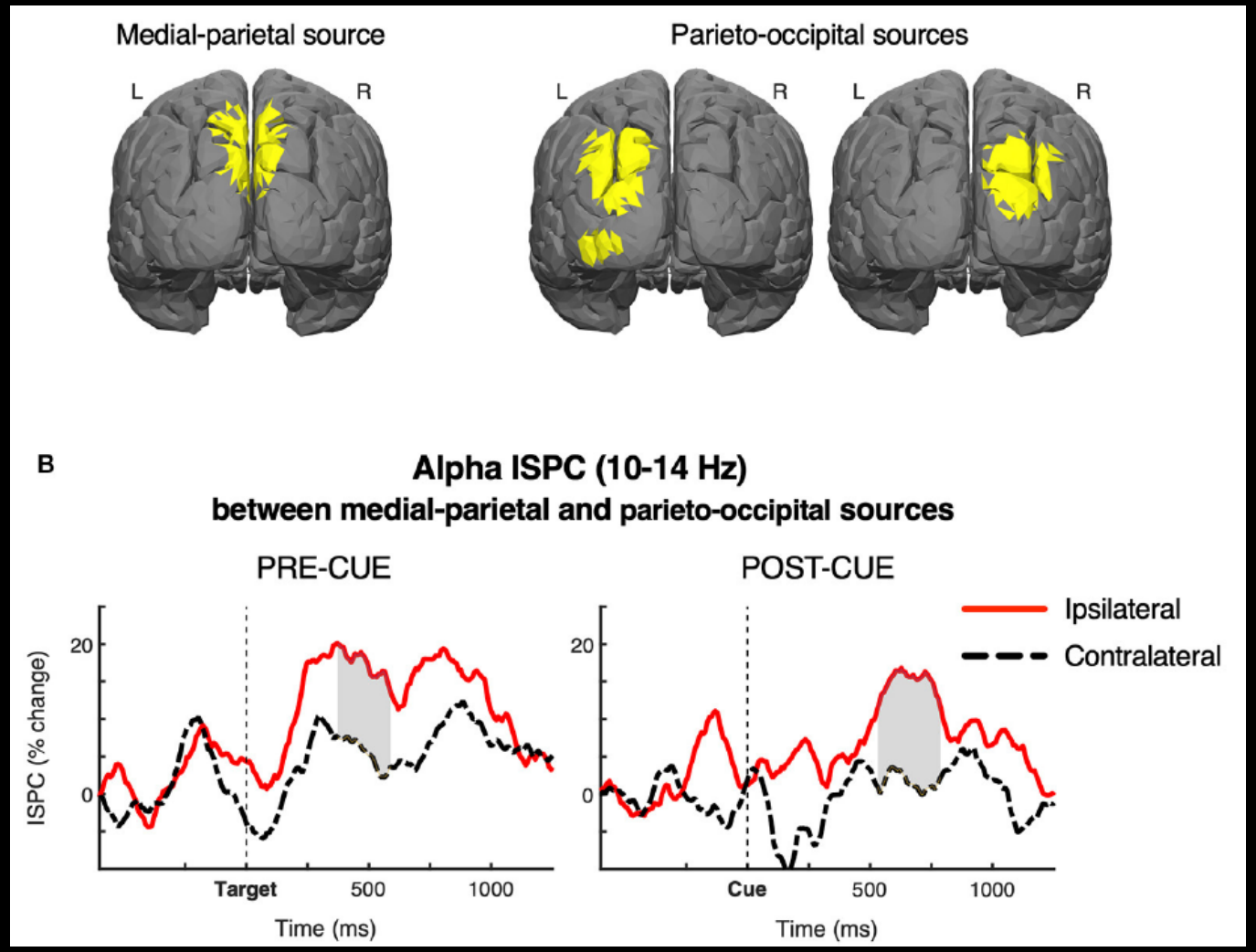
Increased connectivity between parietal and occipital sources



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Retrieval from Memory & Affordance Competition

Connectivity patterns in the case of memory retrieval cannot be interpreted as affecting perception, there is no lateral stimulus.

The data may indicate that the suppression of an action related to the memorized object is released.

There is not a lot of interference between different actions as no new stimuli are being presented, short-range alpha modulations may be sufficient to enable selection of the appropriate action.

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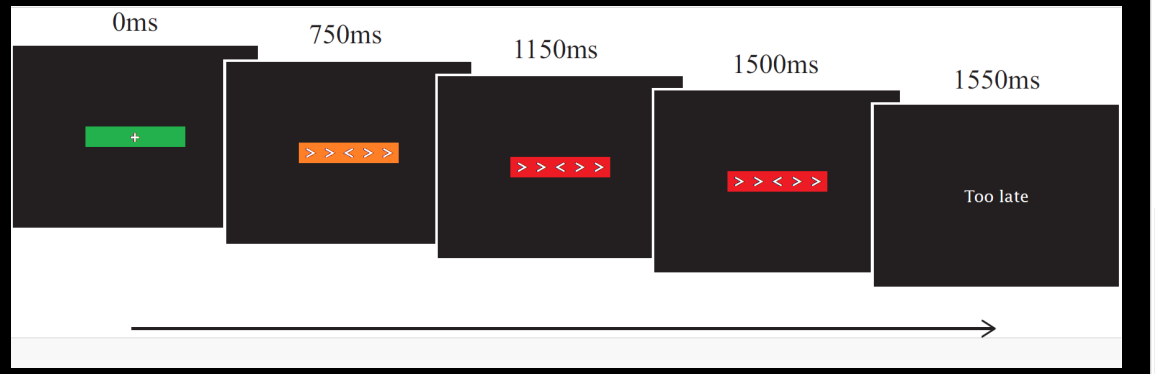
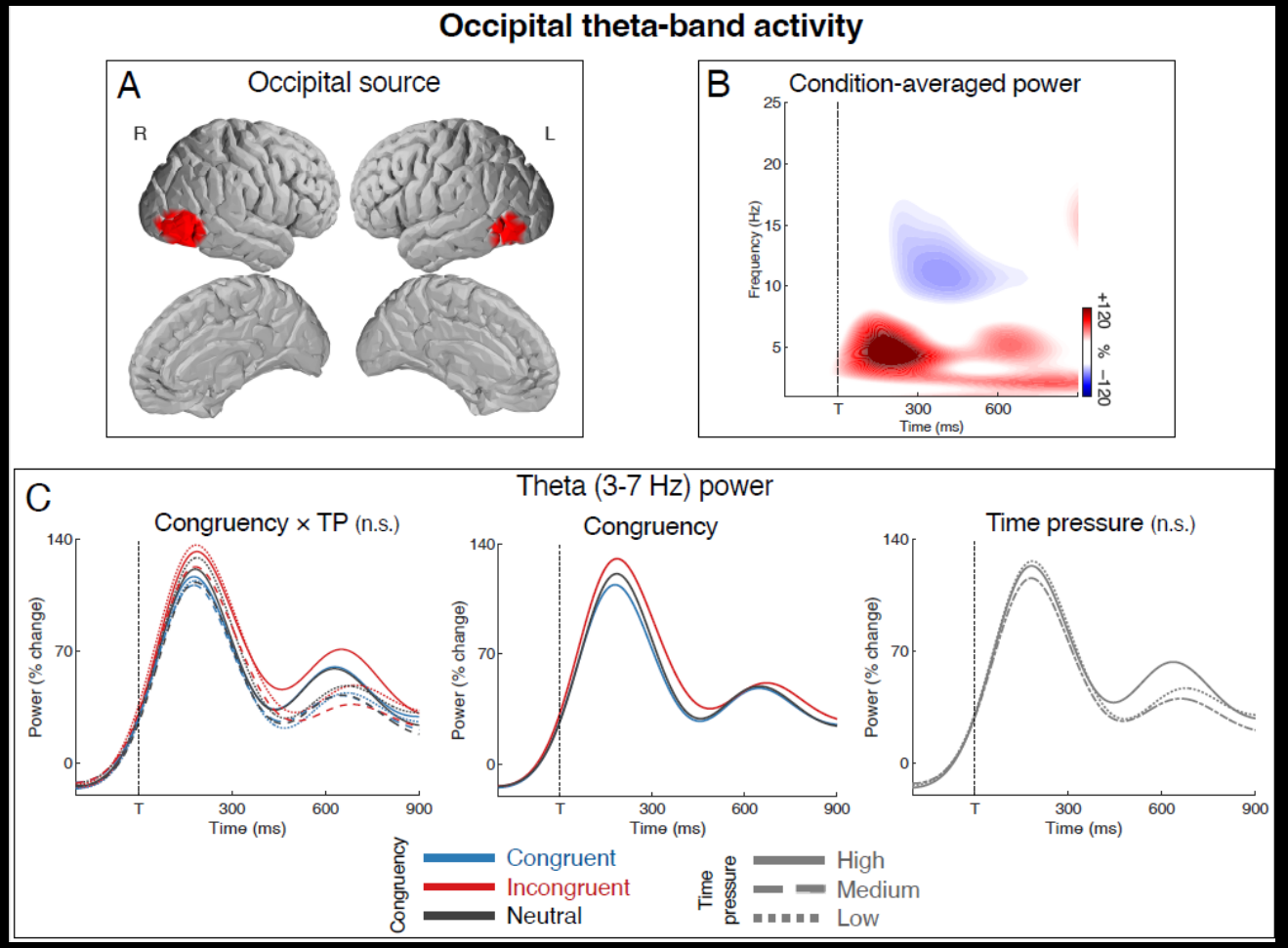
Boosting Action Selection in the Eriksen Task with Time Pressure (Van der Lubbe et al., in prep.)





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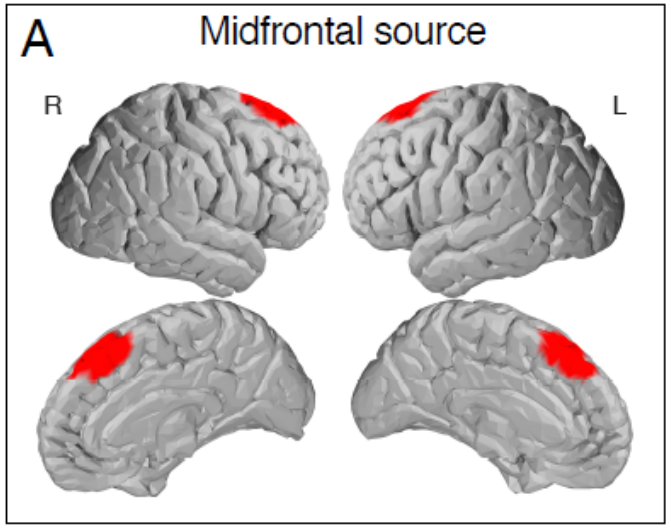
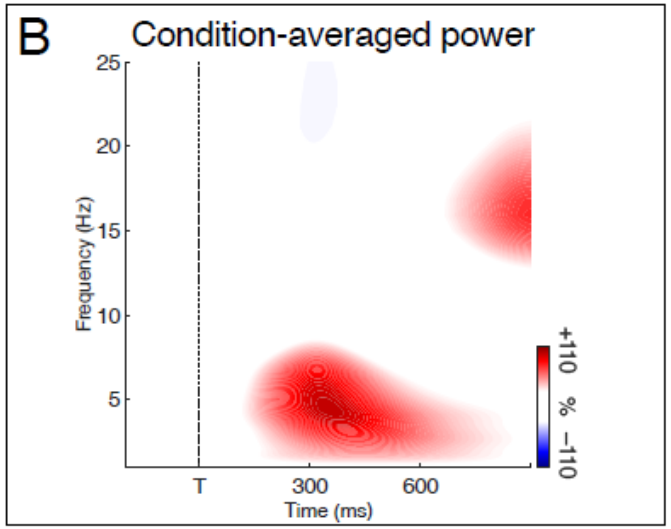
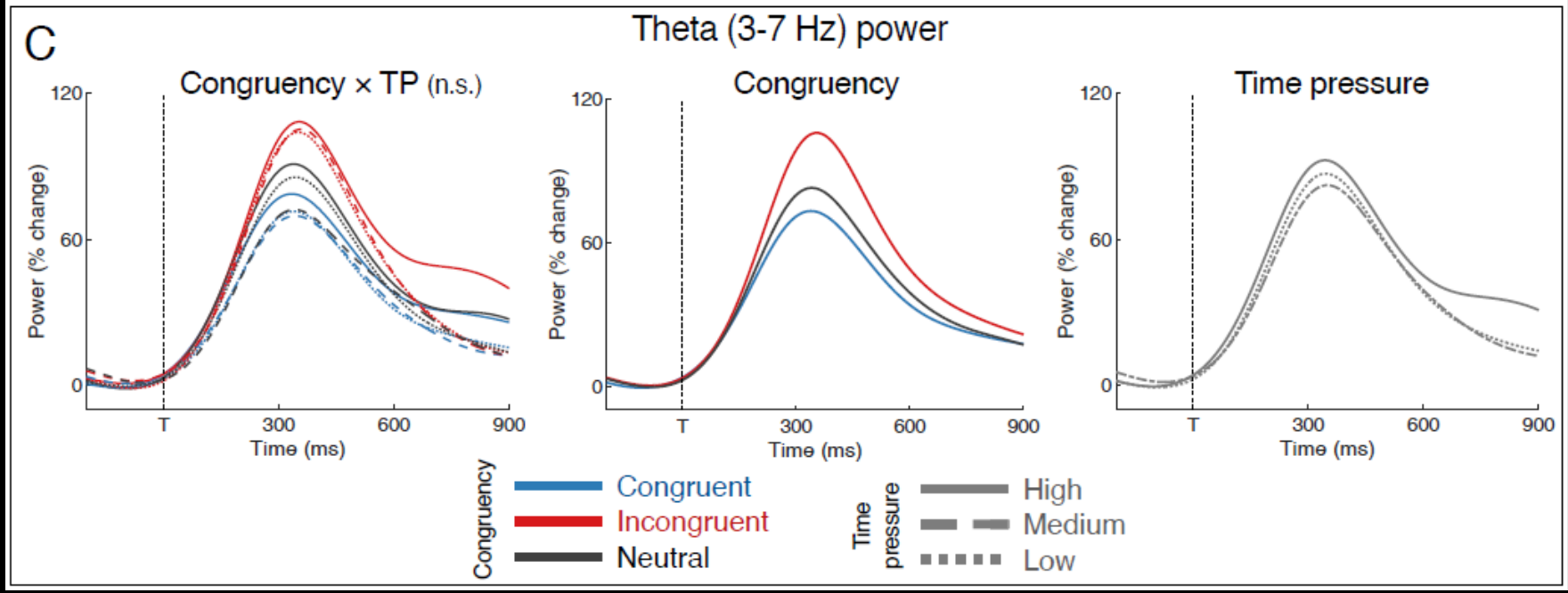
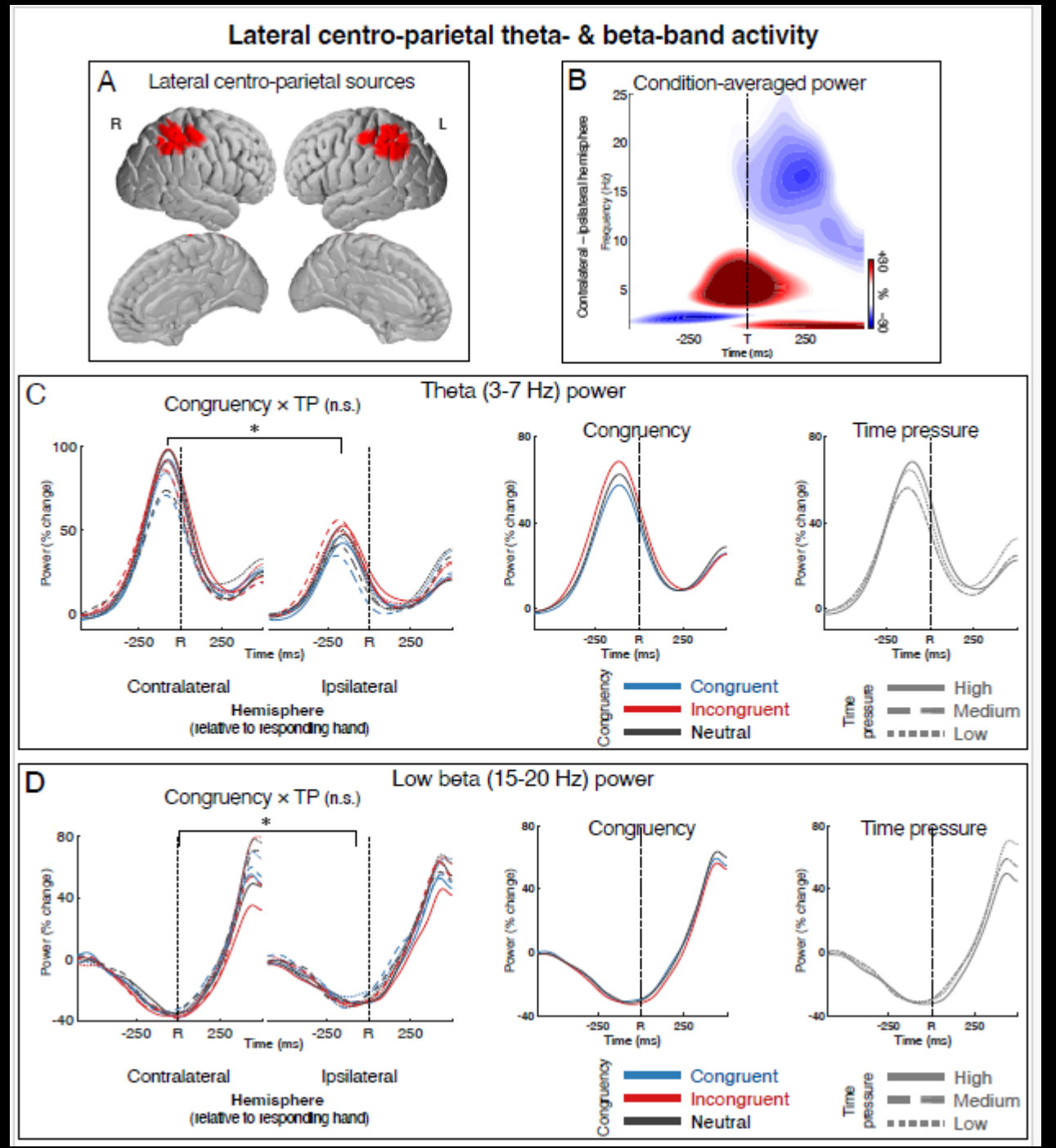
Midfrontal theta-band activity









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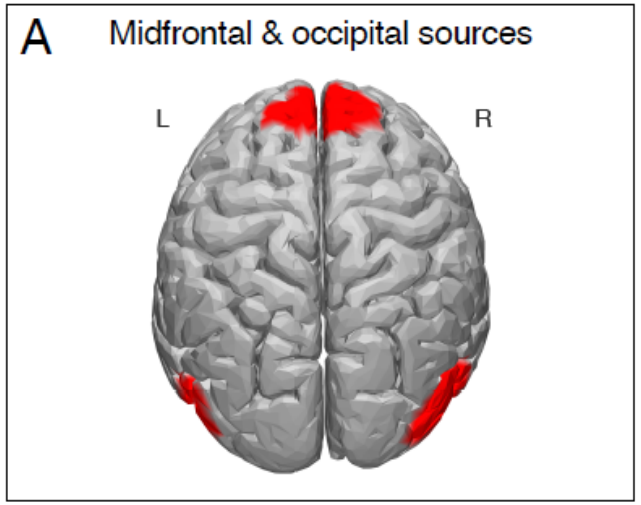
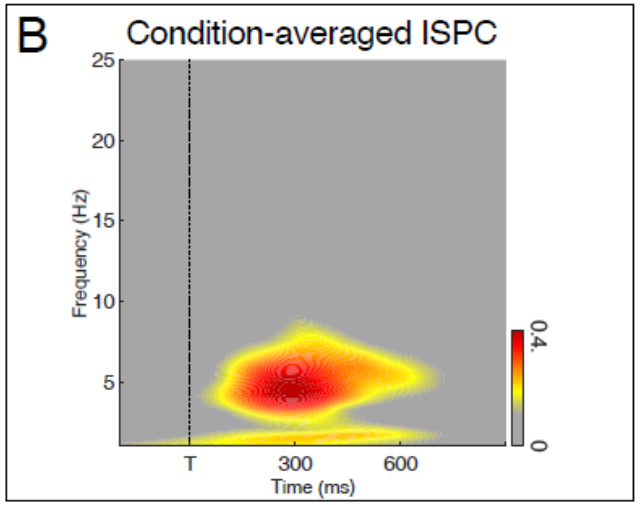
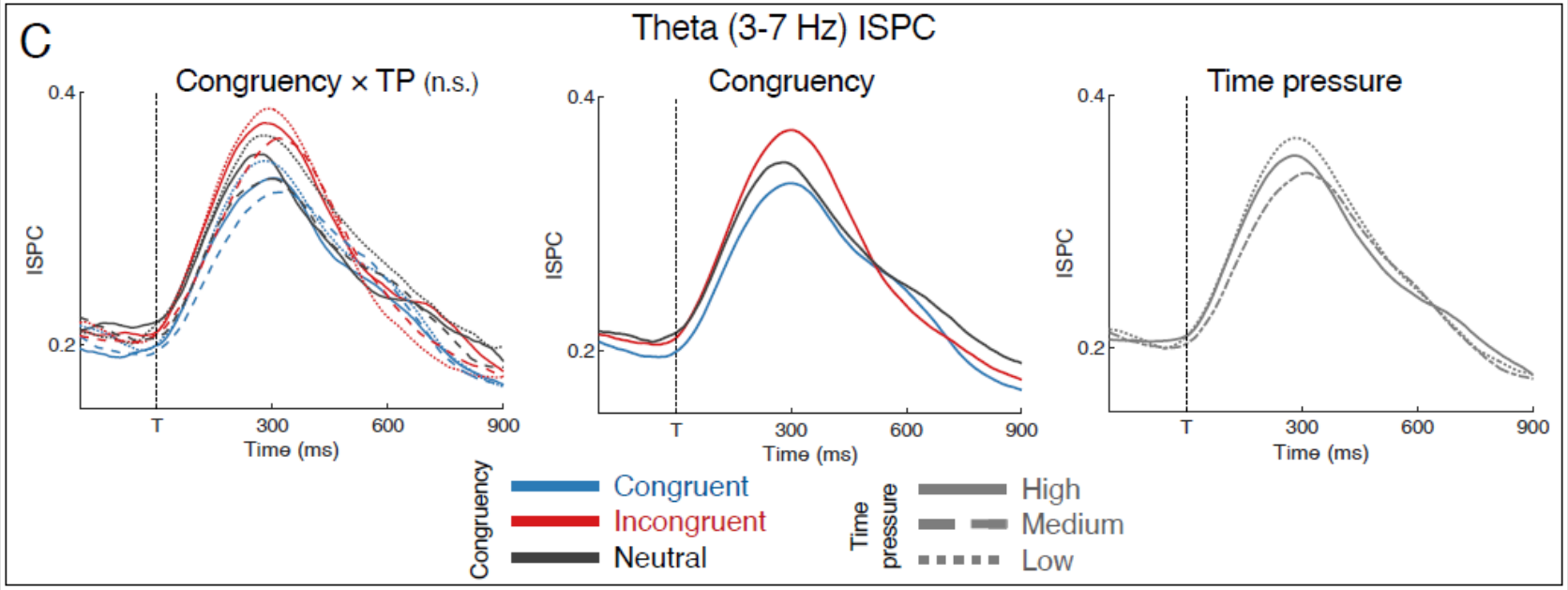
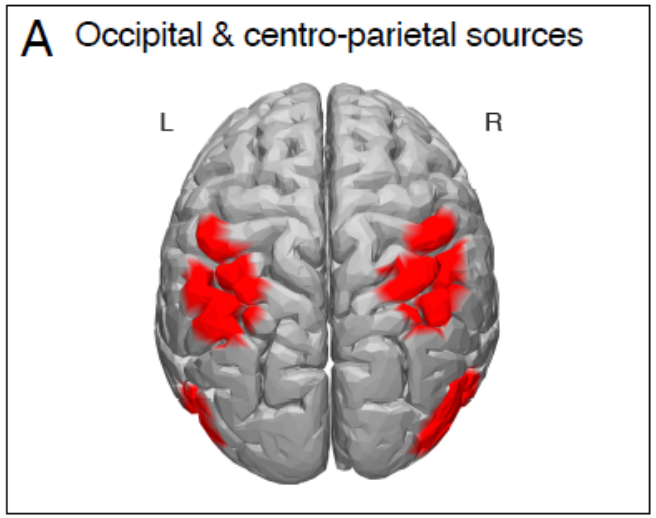
Theta ISPC: Midfrontal <–> Occipital

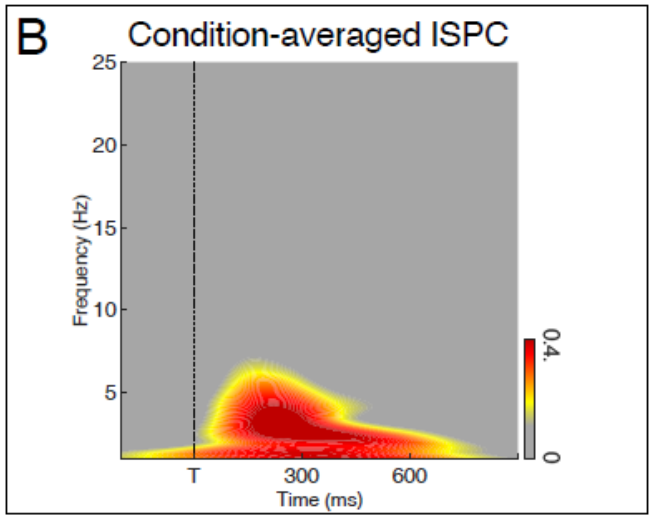


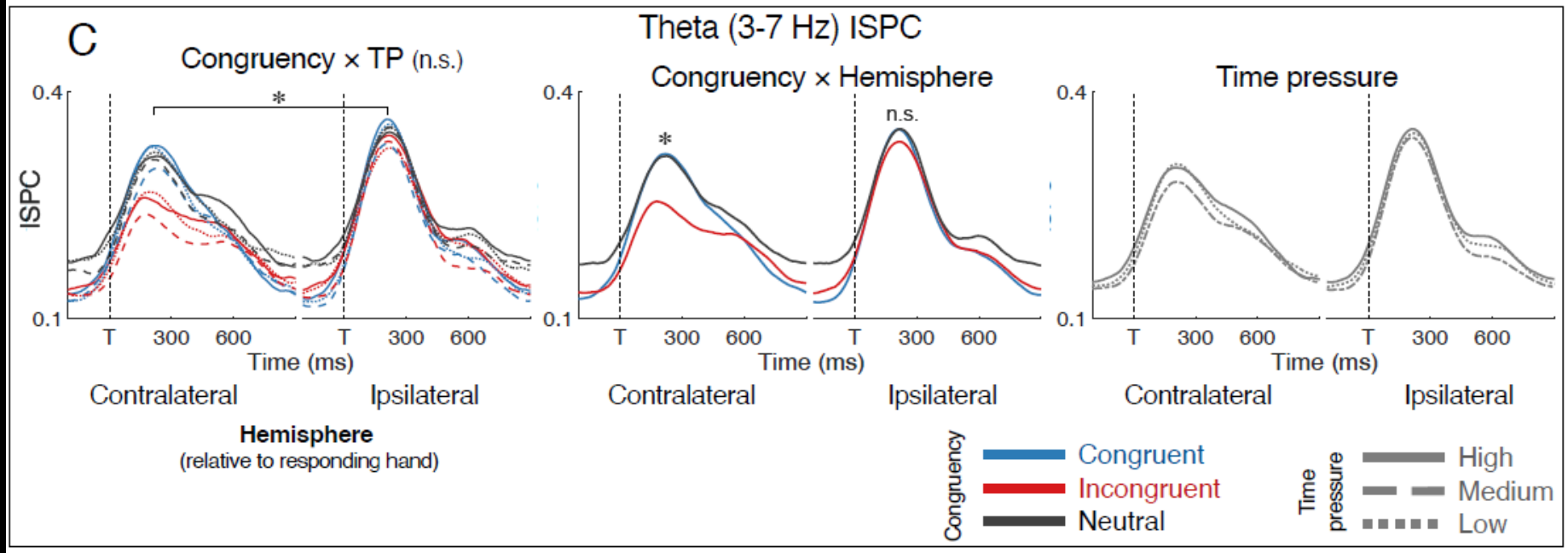




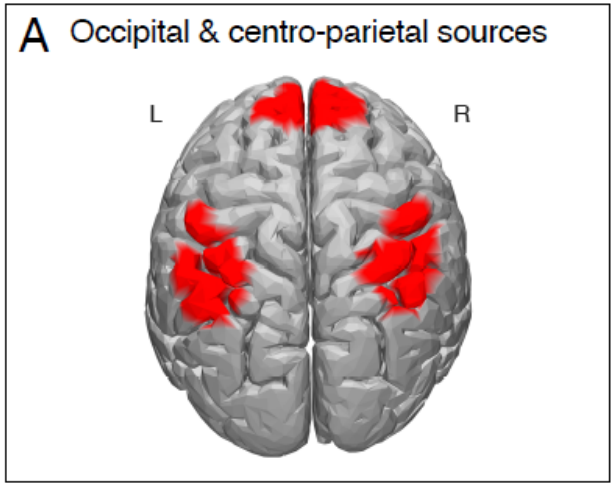
Theta ISPC: Occipital <–> Lateral centro-parietal

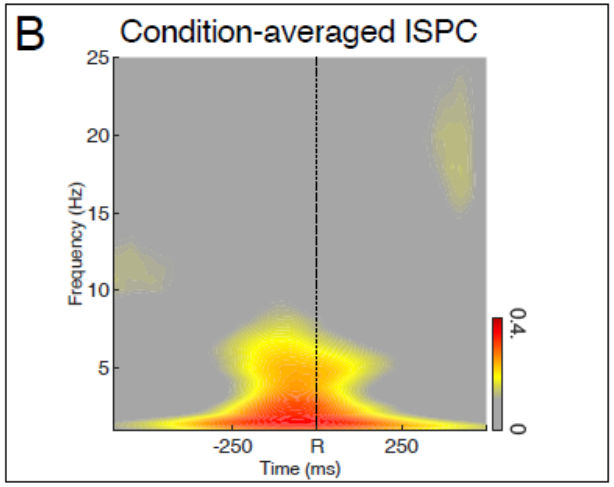


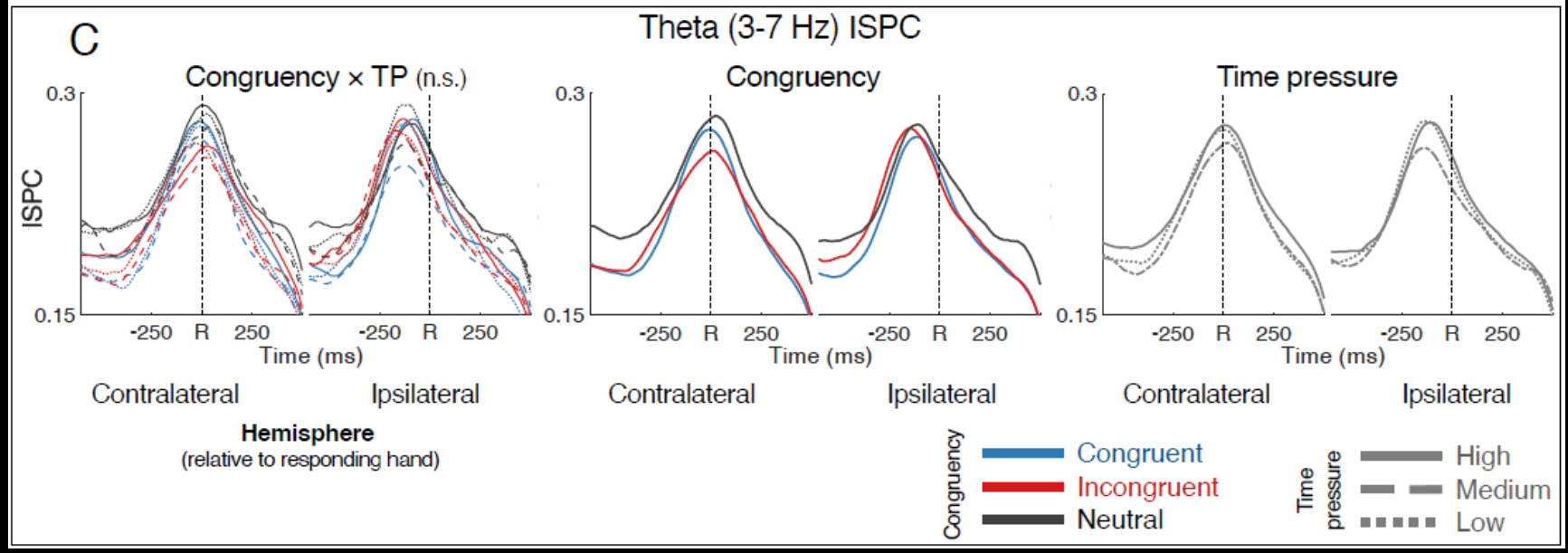


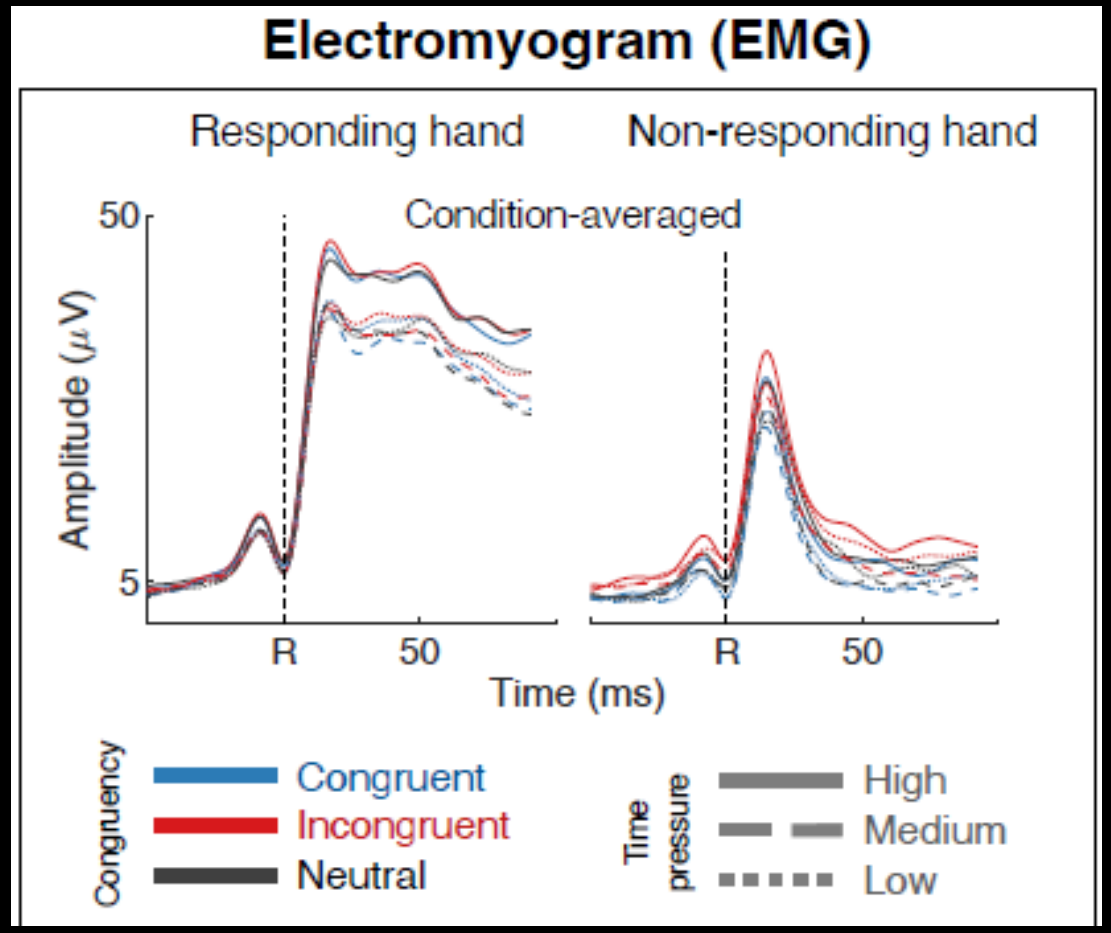


Theta ISPC: Midfrontral <–> Lateral centro-parietal









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Boosting Action Selection

Observations in line with Affordance Competition:

- Increased occipital theta power for incongruent arrays
- Increased connectivity between midfrontal and occipital areas in the case of incongruent arrays
- Decreased connectivity between visual and contralateral motor areas in the case of incongruent arrays
- Stronger connectivity between midfrontal and motor areas in the case of high/medium TP relative to low TP
- Less connectivity between midfrontal and contralateral motor areas for incongruent trials
- Motor activation of the non-responding hand

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Take home messages

- Observed finding seem to fit better with the Affordance Competition Hypothesis
- The operation of Action Selection may very well include Spatial Attention
- The function of Attention appears here not directed at improving perception, but at facilitating specific actions.
- Competition between actions can continue up to the latest moment of response execution.

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Take home messages (continued)

- Alpha and Theta connectivity seem related to closer and long distance interactions, respectively, in line with the proposal of Buzsáki (2006).
- Observations over motor areas remain a bit puzzling as theta seems here not related to inhibition …

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