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Hypnotic suggestions and the Stroop test: neurocognitive mechanisms of the more accurate performance in hypnosis

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Introduction

Hypnosis may reduce automatic cognitive processes (for a review see Lifshitz et al., 2013)

Raz and colleagues: hypnotic suggestions to see words as meaningless symbols can reduce (Raz and Campbell, 2011, Raz et al., 2005, 2006, 2007) or even eliminate (Raz et al., 2002, 2003) the Stroop effect in highly hypnotizable individuals (Higs).

YELLOW BLUE ORANGE
BLACK RED GREEN
PURPLE YELLOW RED
ORANGE GREEN BLUE
BLUE RED PURPLE
YELLOW RED GREEN

Introduction

HYPNOSIS AND STROOP TEST: NEUROPHYSIOLOGICAL STUDIES

Casiglia et al. (2010): the posthypnotic suggestion of inability to read removed the incongruity effect on the N400 component.

Zahedi et al. (2019) proposed a semantic locus of the effect and enhanced executive control associated with the increased frontal N1

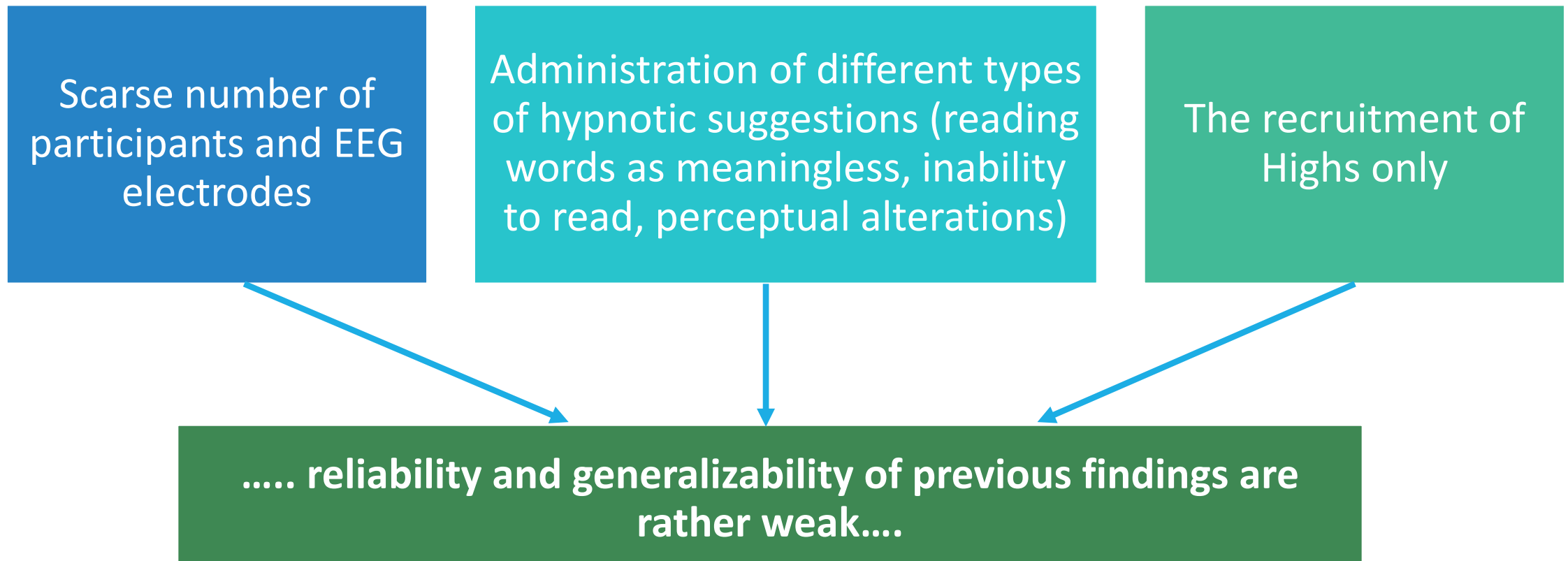
Raz et al. (2005) combined EEG and neuroimaging data. Posthypnotic suggestion to see Stroop words as nonsense strings decreased activity in the cuneus and the anterior cingulate cortex (ACC).

Egner and colleagues (2005) at the opposite observed increased anterior cingulate cortex (ACC) activity for Highs when compared to low hypnotizables (Lows) and a decrease in functional connectivity between frontal-midline and left frontal lateral sites. Results were interpreted in terms of a functional dissociation of conflict monitoring and cognitive control processes in Highs.



Introduction

Limitations of previous studies



Aims of the study

To target different stages of reading processes by adopting a within-subject design and providing two hypnotic suggestions that might affect sensory processing (*perceptual* suggestion) or semantic integration (*semantic* suggestion).

To record the event-related potentials (ERP) activity from distributed brain areas and in both the pre-stimulus (expectancy) and post-stimulus stages of processing.

Administration of suggestions during alert hypnosis instead of posthypnotic suggestions and the recruitment of participants regardless of their responsiveness to hypnosis

Materials and Methods

PARTICIPANTS

Seventeen healthy volunteers (13 females; mean age=23.5 years, SD=6.7)

Harvard Group Scale of Hypnotic Susceptibility Form A (HGSHS-A) score: 7.1 (SD=1.9)

TASK

Manual Stroop task with word stimuli of three categories (Congruent, Incongruent, Neutral). A total of 324 stimuli (108 for each category) were provided

PROCEDURE

Three sessions. In the first session, the individual level of hypnotic susceptibility was assessed, and in the second and third sessions EEG activity was recorded while subjects performed the Stroop task.

Materials and Methods

Participants performed the Stroop task in both the control (C) and the alert hypnosis (H) conditions. Hypnosis condition included the **perceptual** or **semantic suggestion** (randomized order of conditions and suggestions)

- Perceptual suggestion: “... *Your gaze will be captured by the central letter of each word. Your attention will be completely absorbed by the central letter, which will appear as very bright. Any other letter of the word will appear deformed, blurred, less luminous, and further away from the central letter...you are not interested in perceiving them. You will be able to attend to the central letter only..*”

- Semantic suggestion: “...*They will be characters of a foreign language that you do not know, and you will not attempt to attribute any meaning to them. You will look straight at the unknown words and crisply see all of them..*”

Materials and Methods

ERP ANALYSIS

The EEG signal was recorded through 32 scalp electrodes

Two different segmentations were adopted to look at the ERP activities:

- prestimulus analysis: 2000 ms epochs (from -1100 ms to 900 ms after the stimulus);
- poststimulus analysis: 1200 ms epochs (from -200 ms to 1000 ms after the stimulus).

Neuroelectric source imaging was conducted using the minimum-norm method (MNM)

BEHAVIORAL ANALYSIS

We considered the response times (RTs) and percentage of errors (ERR) for the Stroop categories. The main effects of the Stroop task (facilitation, interference, inhibition) were calculated as well.

	Hypnosis			Control		
	<i>Neutral</i>	<i>Congruent</i>	<i>Incongruent</i>	<i>Neutral</i>	<i>Congruent</i>	<i>Incongruent</i>
			Perceptual suggestion			
RT (ms)	612 (71)	606 (74)	682 (85)	600 (68)	602 (71)	672 (91)
ERR (%)	5.7 (2.9)	3.9 (3.5)	7.0 (5.1)	6.6 (3.2)	5.0 (3.2)	8.7 (6.6)
			Semantic suggestion			
RT (ms)	587 (65)	587 (74)	659 (93)	590 (62)	595 (66)	671 (105)
ERR (%)	6.5 (2.9)	4.6 (3.5)	7.3 (5.4)	6.6 (3.6)	5.2 (4.5)	8.8 (5.6)

Behavioral results

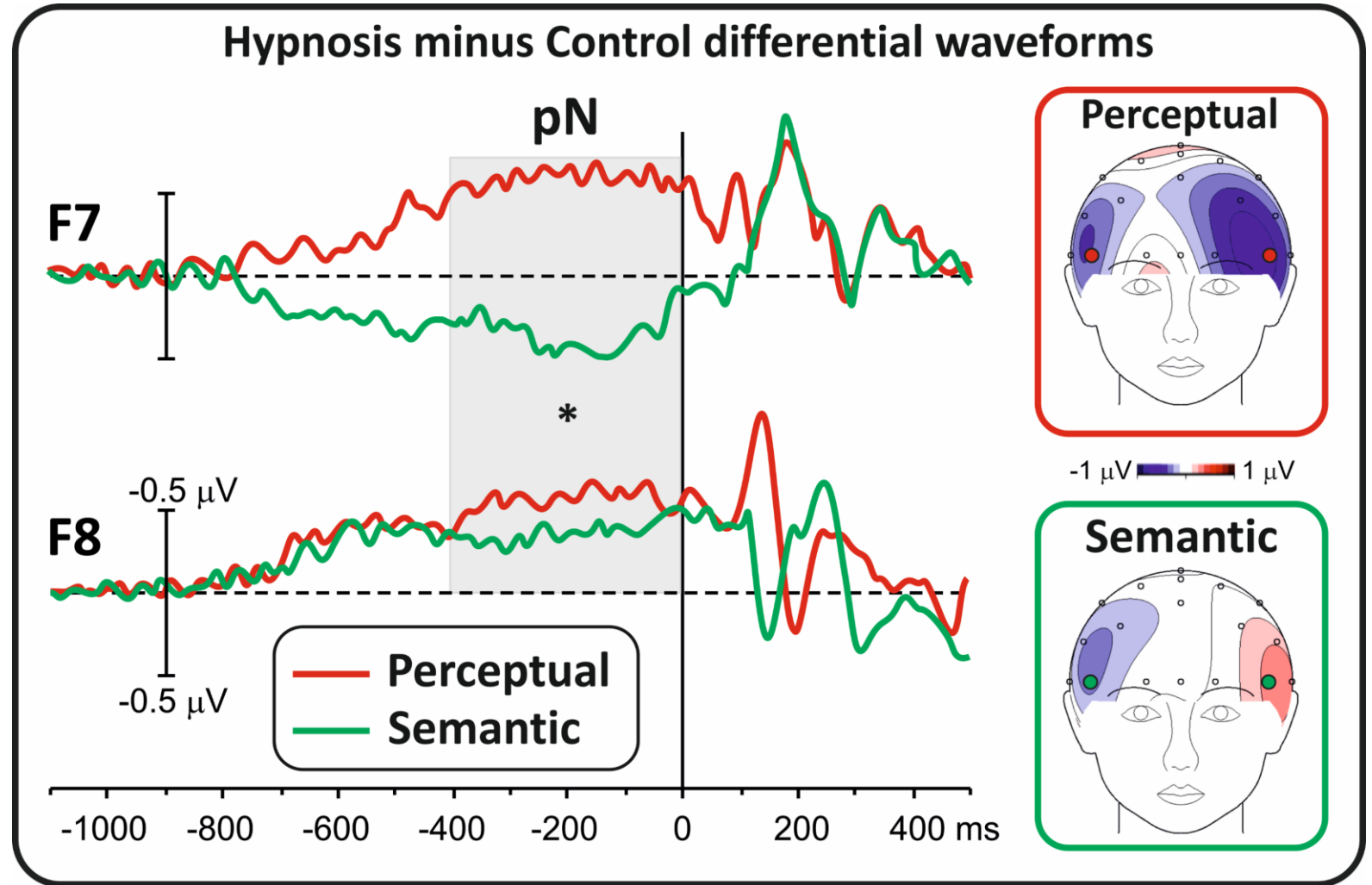
Analysis on errors showed a significant effect of Condition indicating increased accuracy during **Hypnosis (5.8%) compared to Control (6.8%)** conditions, regardless of the adopted suggestions (semantic or perceptual).

No effects of Condition for the RT and the Stroop effects (interference, inhibition, facilitation).

ERP results: prestimulus activity

Differential waveforms (Hypnosis minus Control)

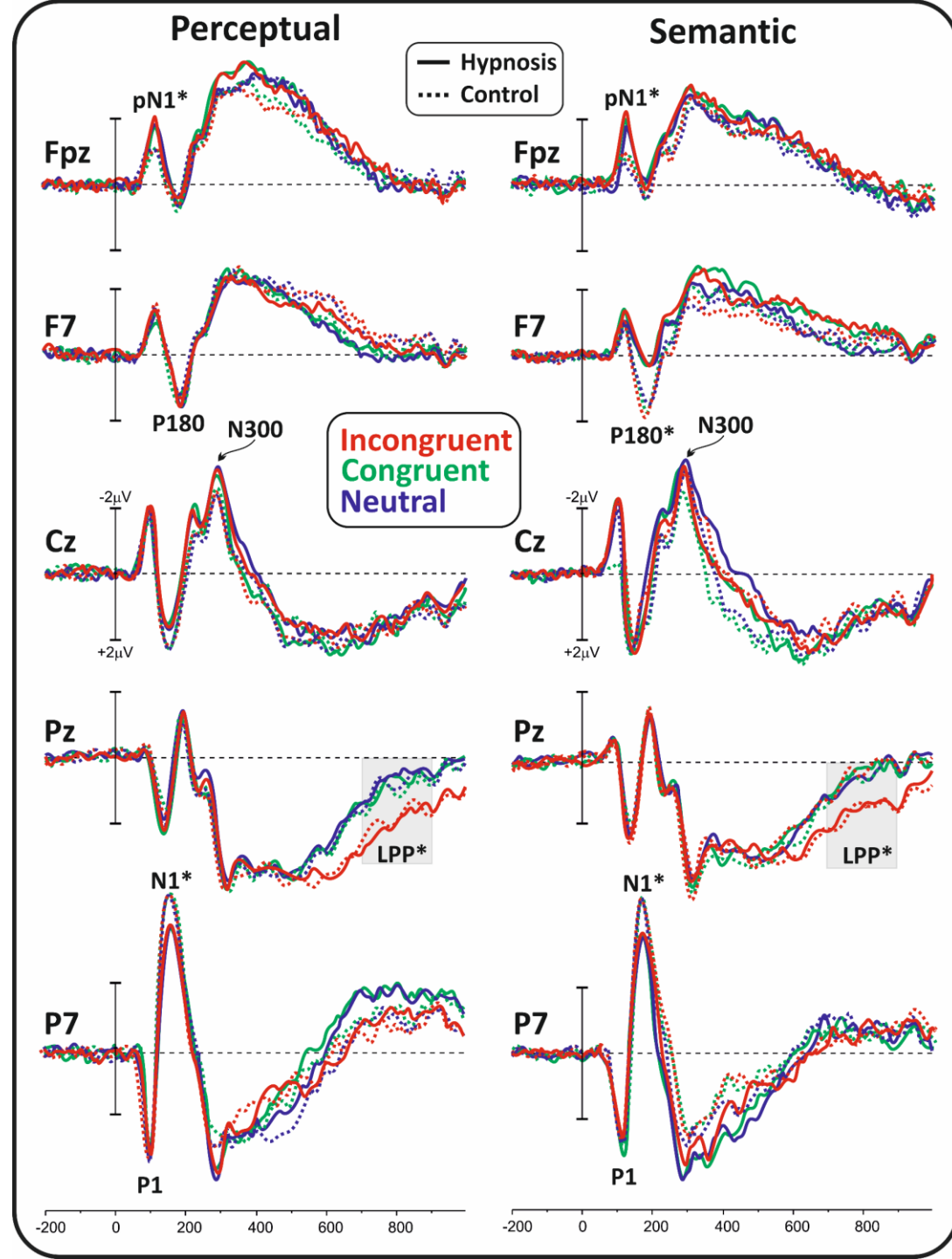
Prefrontal cortex activity
before the stimulus onset:
the prefrontal negativity
(pN) component.

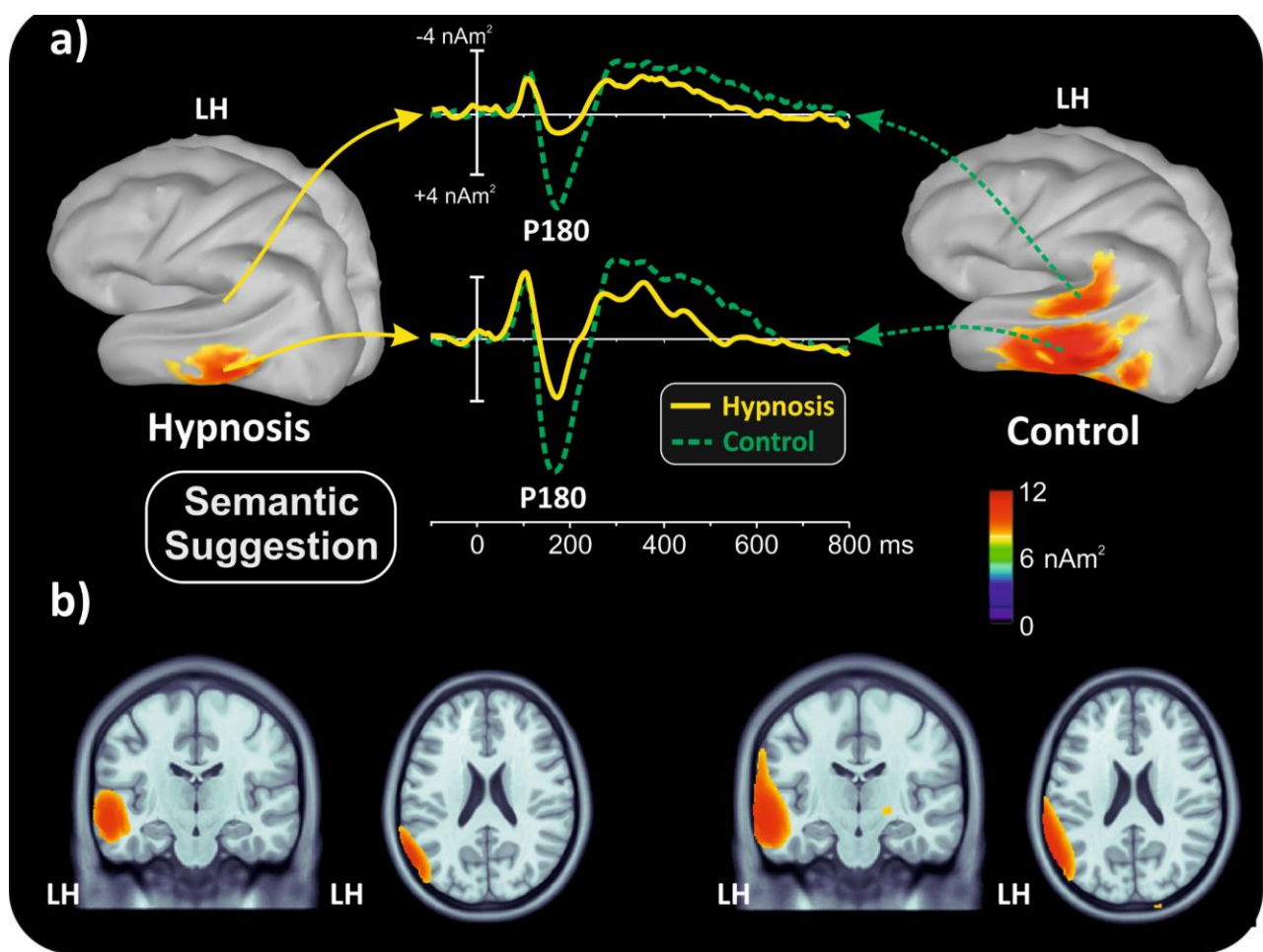
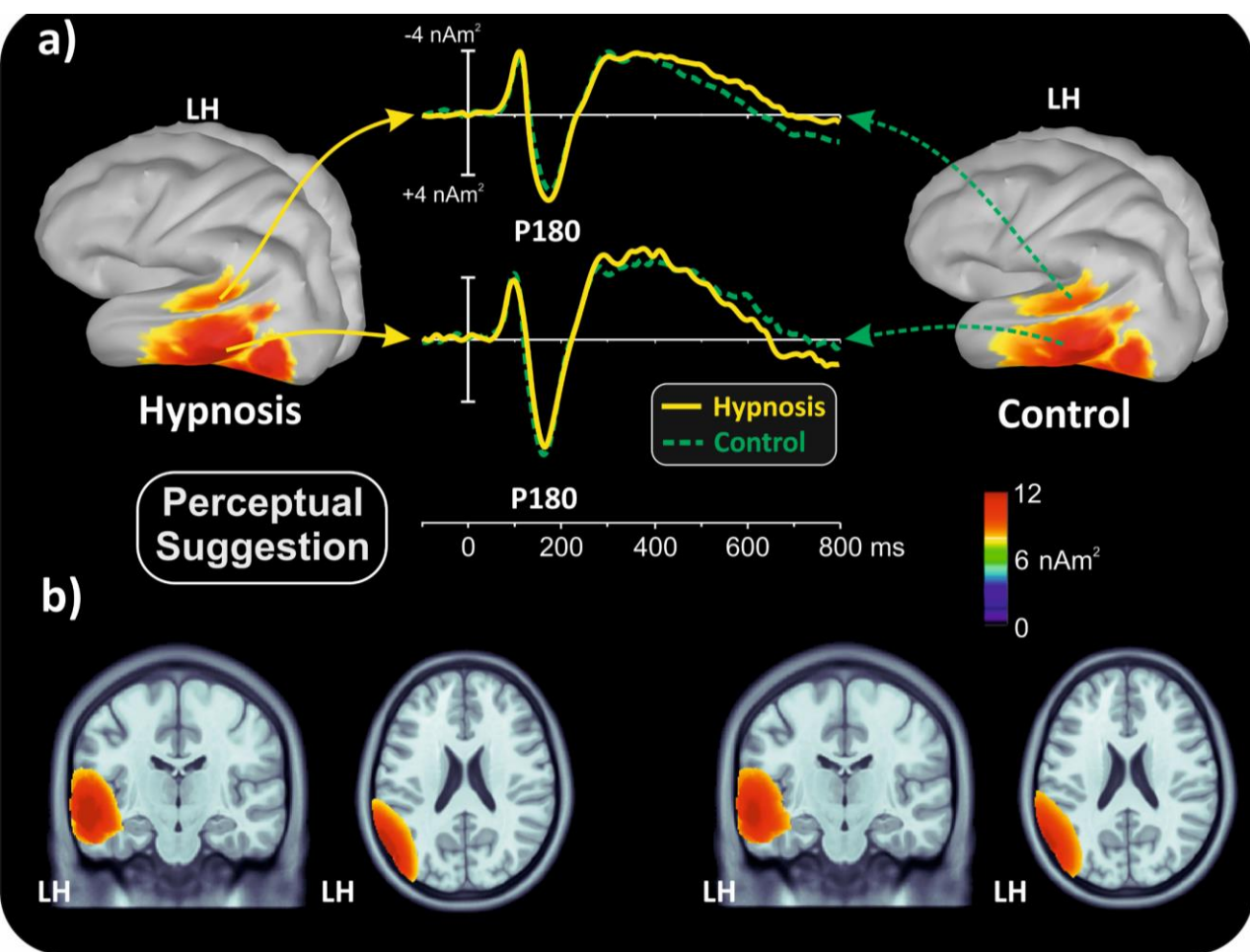


ERP results: poststimulus activity

ERP COMPONENTS

- P1: not affected
- pN1: ↑ hypnosis
- N1: ↓ hypnosis
- Left P180: ↓ semantic hypnosis
- N300: not affected
- LPP: ↑ incongruent stimuli





Neuroelectric source imaging

P180 component was generated in the left temporal lobe, that was recruited less in semantic hypnosis

Discussion

Behavioral performance

We observed **reduced errors** on the Stroop task **during the hypnosis** condition. The effect was similar across the subsamples of Mediums and Highs, suggesting the potential benefit of hypnosis on response accuracy existed regardless of hypnotizability level.

Brain activity

The perceptual suggestion engaged more executive control of the PFC during the preparation stage (increased pN component)

The semantic suggestion affected the graphemic analysis of the words by deactivating the left temporal cortex

Both perceptual and semantic suggestions favored an increase in sensory awareness from the anterior insula (pN1 component), together with a reduction in discriminative attention from the occipital cortex (N1 component).

Conclusion

Present findings suggest that hypnotic suggestions acted through common and specific top-down modulations of perceptual and cognitive processes.

Hypnosis did not suppress reading but facilitated or inhibited specific presemantic stages of stimulus processing, which in turn allowed more accurate performance

Further, the present findings might be considered potentially **representative of the general population** given that we included both Highs and Mediums, the latter having been neglected in most studies.



F U N D A Ç ã O

Bial



THANK YOU FOR YOUR ATTENTION

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