with larger amplitudes for target than standard. The short and long ISIs yielded no reliable initial HR deceleration differences, but the late acceleration was observed for the long-ISI condition only. Correlational analysis between HR and P300 measures indicated that people with smaller HR deceleration had larger P300 amplitude suggesting that the larger target/standard differences for HR deceleration and P300 amplitude, observed at an experimental level, are reversed at an individual level. This apparent dissociation between experimental and correlational data may be explained by the different sources of variation involved in within-subject experimental manipulations, usually simple basic mechanisms, and in between-subject individual comparisons, usually complex multifactorial mechanisms. If this explanation is accurate, the present findings suggest that the biphasic HR response recorded during the P300 oddball task allows, at an experimental level, the differential assessments of the two basic processes involved in the P300: attention (the initial deceleration) and memory (the late acceleration). (This study was supported by Spanish Ministry of Economy and Competitiveness, grant PSI2011-28530).

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Introduction: brain-heart interactions with EEG and fMRI

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I will give an introduction to the techniques which can reveal brain-heart interactions using measures of heart rate paired with two more common neuroimaging techniques: electroencephalography (EEG) and functional magnetic resonance imaging (fMRI). I will first present an overview of the directed dynamical interactions between heart rate variability and the different EEG rhythms, and then I will show which regions of the brain, and their interactions, are more influenced by heart rate, circulation and other autonomic parameters.

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The effects of cardiorespiratory biofeedback associated with the misattributions instructions on the autonomic and central nervous system

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The cardiorespiratory biofeedback is a technique that proposes to influence the autonomic modulation by self regulation. This study investigated the cardiorespiratory biofeedback effects associated with positive misattribution instructions and neutral instructions on the HRV index and cardiac coherence before and during the session, and on the ERPs (event-related potentials) post session, for an error detection task and a conflict detection task. We investigated 52 subjects, divided into two groups: positive misattribution instructions group and neutral instructions group. The participant did not know that the session it was the cardiorespiratory biofeedback but all were instructed to train the slow abdominal breathing and to try learning with the feedback. The results suggest effects of misattribution instructions on cardiac coherence and HRV index, but the effect of misattribution instructions decreased after participants engaged in the biofeedback task. For the ERPs, the positive misattribution group showed lower amplitude of the ERN during Go No/Go task and higher amplitude of the positive ERP around 700-800ms during Emotional 12 Stroop task. The ERN was related to error detection for Go No/Go task and the positive ERP around 700ms - 800ms was related to the SP component (slow potential conflict) of Stroop task and may related to the monitoring and implementation of attention for emotional conflict task. There were no differences between groups for cognitive performance. The difference between groups on the ERPs suggests that these components can be influenced by emotional state, even without the cognitive performance differences.

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New 21st century approaches to P300 research in humans

Organizer: Bruno Kopp (Germany) and Francisco Barceló (Spain)

The late positive complex (P300) of the event-related brain potential (ERP) received intensive scientific investigation until around the beginning of the 1990s. Since then, interest in the P300 gradually waned. The P300 is decomposable into multiple separable ERP components: the P300 incorporates the anteriorly distributed P3a component, often followed by a second parietally distributed P3b component at variably delayed latencies. The 'context updating' model represents the most widely known and respected conceptual theory in the P300 field (Donchin & Coles, 1988). This model postulates that the P3b is evoked in the service of meta-cognitive processes that are concerned with maintaining a proper representation of the environment, such as the mapping of probabilities on the environment, the deployment of attention, or the setting of priorities and biases. A well-developed functional theory of the P3a is so far lacking, although it has traditionally been associated with the brain's orienting response to novel and/or salient stimuli, which may be task-irrelevant. The functional significance of these two ERP components seems to be related to uncertainty (Sutton et al., 1965), surprise (Donchin, 1981), and decision-making (O'Connell et al., 2012) induced by unpredictable events. These data imply that the functional significance of these ERP components reflects -in ways that have yet to be specified - the informational content that these events convey, rather than their physical characteristics. We assemble new theoretical and methodological developments that are potentially capable of reviving scientific interest in the P300.

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A taxonomy of fronto-parietal P3-like positivities based on information theoretic models of cognitive control

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Background: Event-related potential (ERP) research on task-switching reveals distinct transient and sustained positive waveforms (latency circa 300-900 ms) while shifting task rules or stimulus-response (S-R) mappings. However, it remains unclear whether such switch-related positivities show similar scalp topography and index context-updating mechanisms akin to those proposed for domain-general (i.e., classic P300) positivities in many task domains.

Methods: To examine this question, ERPs were recorded from 31 young adults (18-30 yo) while they were intermittently cued to switch or repeat their categorization of Gabor gratings varying in color and thickness (switch task), or else they performed two visually identical control tasks (go/nogo and oddball). Our task cueing paradigm was designed to examine proactive and reactive control during task rule preparation and execution stages, respectively. A simple information theoretical model helped us gauge cognitive demands under distinct temporal and task contexts in terms of low-level S-R pathways and higher-order rule updating operations. Results: Task demands modulated domain-general (indexed by classic oddball P3) and switch-related positivities – indexed by both a cue-locked late positive complex (LPC) and a sustained positivity (SP) ensuing task transitions. Topographic scalp analyses confirmed subtle yet significant split-second changes in the configuration of neural sources for both domain-general and switch-related positivities as a function of the task and temporal (proactive vs. reactive) contexts.

Discussion: Functionally distinct switch-related ERP positivities showed a centroparietal scalp distribution compatible with a family of P3-like potentials across a large variety of task domains (i.e., attention, memory, language, decision-making, etc). The rostro-caudal scalp topography and intensity of this extended family of P300 potentials critically depends on the temporal context for goal-directed behavior (i.e., proactive versus reactive control modes), as well as on low- and higher-order sensorimotor demands that can be finely operationalized with formal models of cognitive control.

Conclusion: These findings partly meet information theoretical predictions, and are compatible with a family of P3-like potentials involved in functionally distinct neural operations within a common frontoparietal "multiple demand" system during the preparation and execution of simple task rules.

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Electrophysiological signals from the probabilistic brain

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I will present single-trial EEG data and ERP data suggesting that the P300 offers a unique window towards an analysis of probabilistic inference by the brain, achieved through appropriate experimental design in combination with proper computational modeling.

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Computational fingerprints of probabilistic inference in MEG signals

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An influential hypothesis posits that the brain constantly infers the causes of the inputs it receives. Experimental evidence includes signals such as the P300 recorded in electrophysiology. Previous studies showed that the brain tracks the statistics of its inputs and elicits P300 waves when new stimuli deviate from its expectations. The brain seems to track, at a minimum, the local frequencies of stimuli and their alternations (Squires et al Science 1976 and Kolossa et al FINS 2013). Here, we propose that the brain extracts the statistical structure of its inputs by estimating time-varying transition probabilities between stimuli. To test our model, we re-analyzed data from Squires et al, in which subjects passively listened to binary streams of auditory stimuli (denoted A and B). Stimuli were generated randomly with global probability $p(A)=0.5$ (no bias) and $p(A)=0.7$ (biased frequency) in separate sessions. The P300 amplitude was averaged at the end of all possible patterns of 5 stimuli. We computed the optimal model to estimate transition probabilities between stimuli $p(A|B)$ and $p(B|A)$, with a fixed probability, known as "volatility", that these statistics change from one observation to the next. We derived surprise levels (minus log likelihood) for each stimulus in the sequence. We compared this model against alternative models. They differed in 1) the estimated statistic: frequency of stimuli or frequency of alternations between stimuli; 2) whether they assumed changes in the estimated statistics and 3) the type of integration: either perfect (as our model) or leaky. We also included the models by Squires 1976 and Kolossa 2013. Our model reproduced several aspects of the data: surprise levels were modulated by the global and local frequencies of stimuli, and the local patterns of alternations. Bayesian model comparison with BIC, trading goodness-of-fit against complexity, favored our model. To further test that the brain tracks transition probabilities, we augmented the original experiment with two conditions biased toward alternations and repetitions respectively, and we recorded 20 subjects in MEG. As predicted by our model, the brain produced opposite responses to alternations and repetitions in these additional conditions. Overall, our model provides a principled account of the P300 based on statistical learning and Bayes rule. It is parsimonious since volatility is its only free parameter. Our findings suggest that transition probabilities constitute a core building block of statistical inference in the brain.

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Dynamic reorganization of brain functional connectivity networks underlying P300

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How does cognition emerge from neural dynamics? The dominant hypothesis states that interactions among distributed brain regions through phase synchronization give basis for cognitive processing. Such phase-synchronized networks are transient and dynamic,