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Ospedale Pediatrico Bambino Gesù, Roma

Comunicazioni Orali Libere - giovedì 16 novembre 2017 - 12.00 - 13.15

Presentazione Orale

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That's not my voluntary action: disrupting both veridical and illusory sense of agency by applying single pulse TMS over SMA

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Introduction
We previously showed that ownership over a fake hand (i.e., rubber hand illusion) triggers an illusory agency over its movements at both explicit (i.e., misattribution to the own will) and implicit (i.e., attenuation of the somatosensory consequences) levels.
Here we examined the neural signature of such pattern by means of single pulse TMS. We predicted that single pulse TMS over supplementary motor area (SMA), known to be related to motor intention and sensory attenuation (SA), would decrease the stimulus intensity of both self- and embodied-hand generated stimuli.
Participants and Methods
Sixteen healthy right-handed volunteers (age – 24.6±3.4 years, 14 female) participated in the study. First, in the SA baseline, the participants were required to rate the intensity of tactile electrical stimulation on a 0-7 Likert scale; the actual intensity of the stimuli was the same in all trials (2.5 times individual sensory threshold + 4 mA with 300V voltage). The stimulus was delivered to participants' right index finger as a result of a button press. The button press was either executed by the participants (Self condition) or by the non-embodied fake hand (Other condition). In 50% of the trials, self-produced stimulation was preceded by a TMS pulse (115% of rMT) over the SMA delivered 10 ms before participant's button press (Self+TMS condition). Secondly, in the experimental condition that combined RHI and SA paradigms, after one minute of synchronous tactile stimulation, the embodied fake hand pressed the button to produce the same electrical stimulation as in the baseline (Embodiment condition). In 50% of the trials, the fake hand's movement was also preceded by a TMS pulse to the SMA (Embodiment+TMS condition). Participants rated stimuli intensity on the same 0-7 Likert scale. Mean ratings of stimuli intensity were compared between conditions within the baseline and within the RHI+SA paradigm.
Results
Intensity of the stimuli produced by the embodied fake hand was attenuated exactly as the intensity of self-produced stimuli (Self (3.87±1.49) < Other (4.60±1.39), $p<.01$; Embodiment (3.62±1.60) < Other, $p<.01$). Furthermore, in both cases, SA was reduced by the single TMS pulse over SMA (Self < Self+TMS (4.36±1.55), $p<.01$; Embodiment < Embodiment+TMS (3.81±1.63), $p<.05$).
Conclusions
Our results show that: 1) it is possible to create a condition of embodiment of action and motor intention; 2) single pulse TMS over the SMA decreases SA, and therefore, interferes with motor intention for both voluntary and embodied actions. This suggests that the sense of agency triggered by body ownership is actually embedded within the intention-programming system, and provides both behavioral and neural evidence that body ownership per se contributes to human conscious awareness of willed actions.

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Activation of different neural populations by TMS orientation and pulse waveform manipulation: direct evidence from TMS-EEG

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Monophasic and biphasic TMS pulses and coil orientations have been consistently found to produce different outcomes in terms of cortical and cortico-spinal outputs, which have been attributed to the activation of specific neural populations. However, direct evidence supporting this hypothesis is still missing, since studies were mostly based on indirect measures of cortical activation, i.e. motor evoked potentials, cortico-spinal volleys or phosphenes. Critically, these measures can be triggered only by stimulating cortical regions (i.e. M1 or V1), which are not representative portions of the whole cortex. Finally, the vast majority of clinical and research protocols involving TMS or rTMS are performed outside these areas. Here, we investigated, for the first time in vivo, the impact of different coil orientations and waveforms on a non-motor area, namely the premotor cortex, by measuring TMS evoked potentials (TEPs) recorded by an HD EEG system. We aimed at determining if cortical responses evoked by differently oriented biphasic and monophasic pulses diverged, and if these differences indicated activation of specific neural populations. TMS was applied over the right premotor cortex with monophasic or biphasic coils oriented antero-posteriorly, i.e. perpendicular to the stimulated gyrus, or latero-medially, i.e. parallel to the target gyrus. EEG was concurrently recorded from 60 electrodes. We computed, by means of a whole-head, cluster based permutation corrected analysis, TEP differences due to coil orientation and pulse waveform. Latero-medial biphasic TMS evoked greater early TEP components, peaking arund 30-70ms post TMS, compared to the perpendicular direction. These early responses have been linked to cortical excitability properties of the underlying cortex, probably due to the activation of layer V neurons. In line with this, previous research showed that biphasic L-M currents have been shown to induce D-waves, which are a reflection of direct layer V pyramidal neurons depolarization, even at low intensities. Conversely, monophasic pulses oriented perpendicularly to the stimulated gyrus elicited a greater N100, which is a reliable TEP component linked to GABAb-mediated inhibitory processes. This seems the best suited protocol to study, and possibly modulate, neurophysiological processes relying on such connections. In this sense, our data fit well with rTMS findings which report monophasic pulses as being more efficient in inducing inhibitory after-effects following low frequency rTMS protocols, or theta burst stimulation. The current data support with direct cortical evidence the hypothesis that different pulse waveforms and orientations do have different stimulation outcomes in terms of targeted neural population and induced cortical mechanisms, a critical information for the design of any TMS protocol.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381630_H9faxpGerw.jpg
Caption 1: EEG response to Biphasic pulses in the L-M (A) and A-P (B) directions.C) Difference between L-M and A-P orientations (bold channels p<.01)

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381630_H9faxpGerw.jpg
Caption 2: EEG response to monophasic pulses in the L-M (A) and A-P (B) directions.C) Difference between L-M and A-P orientations (bold channels p<.05)

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Stimulation of the dorsal premotor cortex but not of the supplementary motor area impairs performance in a stop-signal task.

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Being able to stop a planned action due to a sudden change in the environment is a distinctive feature of action control. The neural underpinnings of such ability have been widely investigated and some regions have been identified as putative inhibitory nodes, suggesting among the others that right inferior frontal gyrus (rcIFG), pre-SMA, and basal ganglia form an essential inhibition network. It is likely that this network suppress the motor output through a projection to the subtalamic nucleus (STN), since none of the cortical areas involved is directly connected to the primary motor cortex (M1). However, accumulating evidence seems to suggest that in the caudal areas of the premotor complex there is another inhibitory node that should be added to the cortical areas already cited, namely the dorsal premotor cortex (PMCd). Indeed, differently from rcIFG and pre-SMA, PMCd is densely connected to M1. Some studies speak for a role of PMCd in action inhibition, but the clear-cut evidence for the hypothesis that PMCd may exert a distinctive inhibitory function in stopping behaviour is still missing. Our conjecture is that PMCd might be a good candidate site for exerting direct cortical motor inhibition, mediating at the behavioural level the ability to stop an ongoing action. To test this conjecture, we stimulated PMCd with single-pulse TMS and measured the performance of healthy volunteers during a Stop-signal task (SST). SST probes how fast and accurate individuals might be in stopping a planned action triggered by a go-signal when a stop-signal is presented after a certain delay. In the present version of the paradigm, subjects perform a go task, (moving an item with the mouth as quickly as possible from a starting point to a final position). In half of the trials, the go stimulus is followed by a stop signal, instructing the subjects to suddenly interrupt the response and not complete the movement. We delivered TMS after the go-signal, at different timings during the response phase of participants. One group received effective TMS over the PMCd, the other group over a control site also directly connected to M1, the supplementary motor area proper (SMA). Both groups received sham TMS. E*ffective* stimulation error rates are compared with *sham* stimulation error rates. Results showed that TMS over PMCd, but not over SMA, produced an increase in error rates in stop trials, showing a strong difference between *effective* and *sham* stimulation in the STOP-trials only (p=0.0007). When *effective* TMS was delivered over PMCd, the accuracy was severely affected, leading each subject to be less able to inhibit their actions. Participants had no impairments in initiating and completing the mouth movements with *effective* stimulation in no-stop trials. Our data seem to suggest that at a more distal level the pathway leading to voluntary inhibition of action passes from the caudal PMCd, which probably exerts a direct inhibitory control over the primary motor area.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381657_1XRq638P8f.jpg
Caption 1: task

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381657_1XRq638P8f.jpg
Caption 2: results

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AUDIO-VISUAL CROSS-MODAL MODULATION OF CORTICOSPINAL MOTOR SYNERGIES IN PROFESSIONAL PIANO PLAYERS DURING MUSICAL STIMULI: A TMS STUDY.

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Corticospinal output changes, as indexed by transcranial magnetic stimulation (TMS) of the left motor cortex, were investigated in 10 professional piano players during motor imagery (MI) of triad chords to be “mentally” performed with three right hand fingers (thumb, index and little finger). Pianists were asked to imagine five triads in C major, each one composed by a stable IIIrd interval (C4-E4) and a varying third note which could be a Vth (G4), a VIth (A4), a VIIth (B4), a IXth (D5) or a Xth (E5) interval. The Xth interval was supposed to be anatomically impossible for most of the subjects. The execution of each triad had to be imagined while reading it on a pentagram, listening to it from loudspeakers or both reading and listening. The appearance of an empty pentagram served as a control condition in which no MI was required. TMS was delivered to the motor cortex by means of a circular coil placed on the vertex. Motor evoked potentials (MEPs) were recorded from the extensor digitorum communis (EDC), flexor digitorum superficialis (FDS), abductor pollicis brevis (APB) and abductor digiti minimi (ADM). The corticospinal output was facilitated during MI of all chords and progressively increased along with task demands in terms of mental representation of hand extension, reaching significance for the IXth interval. To note, MEPs during MI of the thought anatomically impossible chord (i.e. C4-E4-E5) were less facilitated than the ones of the IXth interval, albeit being the latter smaller in terms of hand extension across the keyboard. Moreover, corticospinal output was similar when chords were presented either visually, auditory or both during MI. This finding was likely to mirror the skillfulness of pianists in the elaboration of musical information acquired through different sensory channels. Principal component analysis identified a specific three-effectors motor synergy - involving ADM, APB and EDC - governing the progressive “mental extension” of the hand. The amount of corticospinal output at ADM during MI of the supposed anatomically impossible chord allowed to distinguish two subgroups of subjects. Interestingly, within the subgroup showing the greatest corticospinal output under this particular condition, amplitude of MEPs recorded at ADM was significantly increased if the triad was simultaneously read and listened during MI. Results demonstrate that corticospinal facilitation in professional piano players can be modulated according to the motor plan, even if simply “dispatched” without actual execution, a finding implying a previously disregarded causal role of the primary motor cortex (where motor synergies are mainly encoded) in the cross-modal elaboration of musical stimuli. Moreover, the willingness of subjects to adopt a given motor strategy influenced the level of corticospinal output during MI of a highly demanding task (i.e. the Xth interval), whose mental execution was also supported by cross-modal sensory stimulation.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381735_0RZRx2k3Ug.jpg
Caption 1: Figure 2 - Principal component analysis revealed a main synergy between ADM, APB and EDC.

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381735_0RZRx2k3Ug.jpg
Caption 2: Figure 1 - Mean MEPs peak-to-peak amplitude for each musical interval, expressed as percent change from baseline. Bars denote standard errors.

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Placebo effect and focus of attention as a new strategy to modulate the motor performance

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Background: The placebo effect is a beneficial outcome that follows the application of an inert treatment. It can influence not only perception (like pain), but also behaviour, for example by improving motor performance. Motor control can be modulated in many ways. One of the most powerful is the focus of attention. In this context, directing attention to the movements of the body (internal focus) or to the goal of the action (external focus) can have different effect on motor performance. The aim of our study was to investigate whether attentional focus and placebo procedures interact in modulating motor performance.
Methods: 60 healthy subjects (25 women; mean age, 23.2 ± 3.3 years) were randomized in 4 groups: placebo group with internal focus of attention (PI), placebo group with external focus of attention (PE), control group with internal focus of attention (CI) and control group with external focus of attention (CE). Subjects performed a motor task by pressing a piston as strongly as possible with the right index finger. The PE and CE groups were instructed to “concentrate on the piston’s movement”; the PI and CI groups were instructed to “concentrate on the finger’s movement”.
The PE/PI groups were verbally informed that treatment with peripheral low-frequency transcutaneous electrical nerve stimulation (TENS) applied on the first dorsal interosseus would induce force enhancement. These groups were also conditioned after TENS application, with a surreptitious amplification of the visual feedback signalling the force level; the CE/CI groups instead, were told that TENS was not effective and they did not undergo the conditioning phase.
Results: The PE and PI groups believed that TENS had been effective and expected to perform better compared with the CE and CI groups. Moreover, the PI group presented higher force levels than the PE group, suggesting that the placebo effect in motor performance can be enhanced with an internal focus of attention.
Conclusion: These findings show for the first time that the placebo effect in motor performance can be influenced by the subject’s attentional focus.

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Across-time MEG decoding reveals the temporal organization of action encoding

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Successful interactions within our environment require representations of our actions in time. During movement execution, the motor system keeps track of the actions we are performing, updating the representations of these actions during their unfolding. At the same time, the brain also needs to represent our planned action as an intended outcome, as we need to match what we planned to achieve with what we are actually executing. Exactly how the human brain represents these different types of action representations – namely, of the on-going movement and of the intended outcome - is still unknown. The aim of this study is to characterise the temporal organization of these action representations in the human brain.
To address this issue, participants were requested to perform a non-visually guided motor task, where they were cued to reach one of two possible targets with their hand. The performance of the movement was triggered by a go cue presented 1.5 seconds after the first cue, which allows dissociating the execution from the planning phase of the movement.
We adopted multivariate pattern analysis (MVPA) of MEG data together with the temporal generalization method. This method consists in decoding between two different conditions (reaching right vs. left target) at specific moments in time. Training and testing if the classifier is done both at the same time point, and across time (i.e., training the classifier at one time point and testing it in another time point). The rationale for adopting this method was to investigate if action-related information is maintained in time (representation of on-going movement) or if the same information is represented at different time points, i.e. during planning and execution (representation of planned action as an intended outcome). We focused our across-time decoding analysis on two different frequency bands, beta and gamma, as they have been previously proposed to play different roles in sensorimotor processing.
Our results showed that the two frequency bands mediate different temporal dynamics of action encoding. In particular, significant decoding for the beta band at specific time-points was evident both during planning and execution. Furthermore, we obtained significant across-time decoding between planning and execution in the beta band, which might be interpreted as a possible matching mechanism between what we intend to do (planned action) and what we are actually performing (actual outcome). By contrast, we observed significant encoding at specific time-points in the gamma band, particularly during action execution, without any significant across-time decoding.
To conclude, we characterized the temporal dynamics of action encoding through MEG decoding. Our results started to reveal the temporal organization of action representations within the human brain, suggesting the crucial role of the beta band in representing action-related information across different time periods.

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An electrophysiological investigation of action observation: evidences for integration of suboptimal movement performances

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Neural priming and facilitation phenomena have been observed in sensorimotor cortical regions during observation of actions. The effects of such visual-motor facilitation have been shown via non-invasive brain stimulation (NIBS) and imaging techniques. Related mechanisms proved to be modelled by practice and influenced by previous motor expertise. Nonetheless, the role of expertise has been primarily studied by focusing on high-level motor proficiency, while the potential effects of coding suboptimal motor performances is still unclear. A first NIBS study highlighted that the responsivity of the sensorimotor system can be modulated by observing poorly-executed actions. To better understand those evidences, we devised an electrophysiological (EEG) study to explore functional correlates of the observation of optimal *vs.* suboptimal execution of complex actions. Electroencephalographic data have been recorded from twenty right-handed healthy young adults while they observed four randomly reiterated videos. Videos depicted a healthy confederate, a minimally-impaired MS patient, a mildly-impaired MS patient, or a confederate trying to simulate mild motor difficulties performing the Nine Hole Peg Test (NHPT), a test tapping on fine motor abilities. EEG data have been processed to extract frequency-domain metrics. Frequency-domain data have been analysed taking into account trials and conditions, so to also explore habituation trends. We observed globally lower beta power during the observation of patients' videos with respect to confederate's videos, even when he simulated poor motor performances. Again, beta activity over somatosensory areas gradually increased across reiterations of the minimally-impaired patient' video. Those evidences corroborate the hypothesis that familiarity with peculiar kinematic patterns might modulate sensorimotor responses to observed actions and they might mirror a progressive integration of slightly suboptimal motor performances into participants' motor schemata. Further, present findings may inform on the innate sensitivity and responsivity of human sensorimotor system.

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Technology-mediated mindfulness intervention: psychometric and electrophysiological evidences from a longitudinal study

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By regularly practicing self-observation and by promoting bodily awareness and awareness of automatic responses (e.g. uncontrolled affective reactions) it is possible to empower self-monitoring and regulation skills, as well as our ability to manage stress coming from everyday events and activities. Further, it has also been shown that regular practice of mindfulness and awareness-based activities helps to reduce discomfort and pathological manifestations in clinical contexts (e.g. chronic pain, depression relapses). Nonetheless, it is worth noting that traditional mindfulness and awareness-based protocols do require rather intense exercise and constant commitment: two aspects that often lead to a gradual decrease of motivation and, consequently, to the suspension of individual practices. The impact of such limitations might be reduced thanks to the support of external devices able to make practice less demanding and to track individual progresses over time, thus lowering the requested effort. The study thus aims at testing the potential of an intensive intervention based on awareness practices and supported by a wearable device on cognitive-affective profile and stress levels. Forty university students presenting mild stress levels took part in the study and were randomly divided in an active control and an experimental group. Both groups were involved in a structured intervention, which lasted 4 weeks and was constituted by brief daily activities. The experimental group, differently from the active control one, underwent mindfulness-based practices with the support of a dedicated device. Short-term effects of the intervention on perceived stress, cognitive performances, and electroencephalographic (EEG) profile have been explored by comparing pre- and post-intervention assessments. Specific resting-state and task-related electrophysiological indices have been computed to investigate potential improvement of neural efficiency. In particular, we focused on a measure of system responsiveness (namely, a quantification of the alpha blocking phenomenon), on a measure related to the balance between relaxation and activation correlates (namely, the alpha-beta ratio), and on event-related attention and executive control measures (namely, the amplitudes of the N2 deflection). Analyses highlighted increased electrophysiological responsiveness indices and frequency profiles consistent with a relaxed mindset in the experimental group. Participants in the experimental group also showed improved attention responses. Even perceived stress proved to be positively modulated by the experimental intervention, as well as cognitive efficiency as measured by a complex reaction times task. Findings suggest that the intensive technology-mediated mindfulness intervention might have been effective at promoting subjective well-being in people presenting mild stress levels.

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Haemodialysis treatment in uremic patients: investigation of the correlation between depression, reward system and chronic fatigue.

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Haemodialysis is considered a life-saving treatment, allowing a good level of survival for uremic patients waiting for organ transplant. Uraemia, if not addressed in an adequate manner, can lead to death. However, treatment greatly influences the patient's life. Eighty percent of patients has chronic fatigue, affecting the quality of life (QoL). Fatigue is a multidimensional symptom. The "physical" dimension is linked to obvious bodily limitations, but recovery mechanisms save all of their effectiveness, allowing to get the strength back as a result of an adequate rest period. The "motivational" dimension, however, is more complex and refers to a central fatigue, often associated with pain, disturbed sleep, affective and cognitive disorders. In spite of studies carried out in groups of patients with chronic disease, suggest that psychological interventions to decrease the fatigue is necessary, these interventions are not available for haemodialysis patients. The aim of this study is to evaluate the level of fatigue, assuming a comorbidity with a past of anxiety and depression, and how the motivation mechanisms are affected with a significant impact on QoL. Evaluative scales have been administered to a sample of haemodialysis patients (N=94) older than 18 years, with no neurocognitive disease. Fatigue Severity Scale (FSS) has been applied to measure the impact of fatigue on motivation and social functionality. BIS/BAS Scale has been administered to investigate the mechanisms of reward: Behavioural Activation System (BAS) and Behavioural Inhibition System (BIS) result in behavioural inhibition/activation to rewards/punishments. Finally, the State-Trait Anxiety Inventory (STAI-Y) and the Back Depression Inventory (BDI-II) have been used to evaluate the potential presence of anxiety and depression disorders. For a qualitative analysis, a semi-structured interview has been performed. The results show a linear correlation between the fatigue and depression level: **a.** Fatigue is directly proportional to symptoms such as sadness, frustration, irritability, difficulty concentrating and loss of interest. **b.** The inclination to act, led by the BAS system, is inversely proportional to depression. Therefore, its indirect correlation with chronic fatigue is conceivable. **c.** The BIS system, on the other hand, is directly related to the sense of fatigue, especially in men. This study shows that the sense of fatigue is not exclusively linked to pathophysiologic factors of uraemia and haemodialysis but to a central fatigue on a psychological level. A psychosocial intervention would be useful to improve the QoL of the haemodialysis patients, lessening the "fatigue" symptom.

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Gambling behavior in Parkinson's Disease: an EEG study using Iowa Gambling Task.

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Characteristics related to the development of Pathological Gambling (PG) in Parkinson's Disease (PD) include personality traits, such as impulsivity, cognitive deficits and the dopaminergic treatment. In the last ten years there was a growing interest towards the study of PD's subgroups of patients with PG, because of the serious personal, social and economic consequences that this disease causes for the patient and his family. Indeed, PG could be defined as a dysfunctional compulsive behavior related to decision making in high risk decisions. A well-validated task used to test the ability to distinguish between high and low risk decisions and to evaluate the situational learning effect is the IOWA Gambling Task (IGT). This study investigates the differences in the decision processes in PD patients with and without PG considering both neurophysiological and behavioral aspects. The sample included fifty-two PD patients (43 males e 9 females, mean age 63,06 years old), in a stable dopaminergic treatment and without dementia. According to their gambling status, participants were divided into three groups: 17 PD patients with active gambling behavior (PDG), 15 PD patients who remitted from PG (PDNG), and a control group (CG) composed of 20 patients with PD only. An EEG registration was carried out during the IGT performance and was analyzed observing the cortical oscillations (time-frequency analysis). EEG results showed an increase of the low frequency bands (Delta and Theta) in the frontal area for the PDG group compared to the other two groups, mainly during disadvantageous and risky options. Instead, the PDNG group revealed a power distribution similar to the CG. At the behavioral level, an impairment in the ability to opt for most advantageous options was observed, with a decreasing gradient from PDG to PDNG to CG. Moreover, this tendency was highly related to impulsivity traits (measured by the Barratt Impulsivity Scale, BIS-11) and reward dependence (BIS/BAS questionnaire subscales score). Overall, the dysfunctional cognitive performance and a low frequency bands response could underline an anomalous cortical answer of PDG patients related to their ability to monitoring and controlling the emotional behavior during a decision-making task where impulsivity and reward mechanisms correlated to risky dynamics are relevant

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Rubber hand illusion susceptibility increases after motor cortex excitability inhibition

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During the rubber hand illusion (RHI), while the subjects perceive a fake hand as part of their own body, the excitability of their primary motor cortex (M1) is decreased, so that they are less ready to move their real hand. Here, we investigated the reverse condition and we asked whether and to what extent modulating the M1 excitability may affect the strength of the RHI.
In a within-subjects, sham-controlled study, we assessed the effect of low-frequency (1 Hz) repetitive transcranial magnetic stimulation (rTMS) of the left M1 on the RHI susceptibility. Subjects, after either rTMS or Sham sessions, underwent the RHI procedure, including both synchronous stimulation of the real and the fake hand (i.e. the experimental condition able to induce the illusion) and asynchronous stimulation (i.e. control condition). Both subjective (embodiment/disembodiment questionnaires) and objective (proprioceptive drift) RHI measures were collected. In order to verify the inhibitory effect of 1 Hz rTMS on M1 excitability, MEPs to single-pulse TMS were collected before and after both rTMS and Sham sessions. Eighteen subjects participated in the Main Experiment, in which the RHI was performed on the right hand, contralateral to the inhibited hemisphere; other eighteen subjects participated in the Control Experiment, in which the RHI was performed on the left hand, ipsilateral to the inhibited hemisphere.
In both Main and Control Experiment, the Hand Stimulation effect was tested in Synchronous vs Asynchronous contrast; the Brain Stimulation effect, in rTMS vs Sham contrast. In both subjective and objectives measures, due to normality issues, data were analyzed with non-parametric Wilcoxon tests. In the Main Experiment, similar results were found in all RHI-measures. The Hand Stimulation effect showed greater values for Synchronous than Asynchronous conditions, in both rTMS and Sham sessions (p always <0.05). Crucially, a Brain Stimulation effect was present only in Synchronous condition, with significantly greater values in rTMS than in Sham session (p always <0.05). In the Control Experiment, only a Hand Stimulation effect was found, with higher values for Synchronous than Asynchronous conditions, in both rTMS and Sham sessions (p always <0.05). Finally, in both Main and Control experiment, a Brain Stimulation effect showed lower MEPs values for rTMS than Sham sessions.
These results showed that, when M1 excitability is reduced by rTMS (as proved by the decreased MEPs amplitude), the illusory experience is strengthened at both subjective and objective levels, (i.e. all RHI measures showed greater values as compared to Sham). Moreover, the effect is specific for the hand contralateral to the inhibited hemisphere. This evidence indicates that when the subjects are less ready to move their own body, their sense of body-ownership is attenuated and they become more prone to incorporate an alien body part.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_380583_QW29WJVr1Y.jpg
Caption 1: Figure 2. Main and Control Experiment Results

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_380583_QW29WJVr1Y.jpg
Caption 2: Figure 1. Experimental Procedure

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Neuroeconomics: taxpayers' brain and personality

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Paying taxes demonstrates the well-functioning of State and it is necessary to finance public goods. Despite taxes are defined as the fuel of civilization and the governments underline the crucial importance of taxation, the understanding of why people pay them remains limited. The present research aimed at detecting the cognitive responses during tax compliance experiment, also by considering characteristics of personality. We evaluated the decision-making process to pay taxes of thirty healthy participants during two different phases: individual phase, where the participant is the only one taxpayer who decides unconditionally whether paying taxes on his income; social phase, where the participant pays taxes with four other taxpayers in order to ensure public welfare. Each phase consisted of twenty rounds in which participants had to decide whether paying taxes. Brain oscillations (delta, theta, alpha, beta) were monitoring within the prefrontal area when subjects expressed their payment intention. At the end of the experiment the taxpayers completed a questionnaire, the Italian version of the tax compliance inventory TAX-I. TAX-I assesses tax compliance and distinguishes between two forms of compliance and non-compliance: voluntary compliance (spontaneous willingness to cooperate, emanating from taxpayers' moral obligation to contribute to the public welfare) and enforced compliance (tax payments according to the law arise from taxpayers' concern of being audited and fined). Especially in social phase, it was observed higher DLPFC delta and theta activity when enforced taxpayers decided to be compliant. DLPFC was more responsive to social phase when enforced taxpayers paid taxes. Probably this result is driven by the enforced taxpayers' preference to be social norm compliant. In line with electroencephalographic results, behavioral data showed how enforced taxpayers decided to pay taxes especially in social phase and evade in individual phase. In the presence of other taxpayers, enforced subjects chose an empathic and pro-social behavior.

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Consumer Neuroscience: TV commercials vs. virtual reality commercials

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In marketing world, it is not enough to commercialize the products only trough traditional channels anymore. Today's consumers research new stimuli and would like to be engaged in different ways. This consumer neuroscience research aimed at detecting the different cognitive and emotive responses during the vision of two types of commercials: traditional TV commercials and virtual reality commercials. Implicit (brain oscillations and physiological indexes) and explicit (subject evaluation) measures were considered in order to understand the different consumer engagement. Indeed, brain oscillations (delta, theta, alpha, beta) and physiological indexes (SCL, SCR, Puls) were monitored, when subject (N=seventeen) observed four traditional TV commercials and four virtual reality commercials in randomized order. During the vision of virtual reality commercials, the participants were absorbed into the advertisement and interacted with it thanks to "Oculus Rift". Subjects were also asked to explicitly evaluate each commercial (on eleven dimensions) and to express their preference on them. The results show a more prefrontal cortex increased theta activity and greater SCL (Skin Conductance Level) in response to virtual reality commercials, evaluated as more emotionally involving and interesting, compared to traditional advertising. It is evident a strong relationship between explicit and implicit measures. The subjects appeared more captivated, enthusiastic and felt like protagonists thanks to a new way to do advertising.

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The topography spatially-oriented behavior in the human premotor cortex: a TMS study.

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A large amount of different motor and cognitive functions has been attributed to the premotor cortex (PM). This behavioural heterogeneity is reflected in the structural heterogeneity of PM that comprises different subdivisions with specific function and connectivity. Converging evidence in non-human primates identified two main subdivisions of the premotor cortex namely the dorsal premotor cortex (dPM) and the ventral premotor cortex (vPM), which are responsible of different aspects of sensori-motor transformations. Despite attempts of homology between the human and the non-human primate's functional anatomy, the functional and structural organization of human premotor cortex is not clear. The goal of the present study is to map with transcranial magnetic stimulation (TMS) in healthy human volunteers the role of the entire premotor cortex (Broadmann's area 6 – BA6) in producing spatially-oriented behaviour.
From the behavioural point of view, we explored the dimension of spatial stimulus-response compatibility, by asking participants to perform a classical version of the Simon task (Simon JR (1969) J Exp Psychol *81*, 174-176) in which subjects typically respond faster when the relative spatial positions of stimulus and response correspond (compatible trials) than when they do not (incompatible trials). We asked participants to produce responses with hands or feet in different blocks. We identified on the participants' left hemi-scalp a grid of 10 points, putatively covering the whole of BA6. TMS was applied online, on each point in a random order, shortly after visual presentation of the target stimulus. We observed clear effects of TMS on behaviour that were specific for the spatial compatibility and for the effector. TMS affected hand responses when applied on spots that were slightly anterior to those where foot responses were affected. Contralateral (right) targets and contralateral responses were affected by TMS applied over a spot located in the mid-anterior portion of the dorsal premotor cortex. Ipsilateral targets and responses seemed to be represented in a more widespread network comprising the dorsal and the ventral premotor cortex. Congruent or incongruent conditions were not represented as such but their localization depended on the side of the target/response. The results indicate that contralateral spatially-congruent behaviour is represented in humans in the dorsal PM. The functional homologue of such region in monkeys is the F4 sector, in the ventral premotor cortex.

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Neurofeedback for emotional behavior regulation. Hemodynamic (fNIRS) and EEG evidences.

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Self-regulation is significantly relevant in habitual operations, improving cognitive and behavioral performances. The neurofeedback (NF) is a non-invasive approach that allows the user to learn how to modify his brain activity by increasing the frequency, the coherence and the amplitude control of his own electroencephalographic patterns. So far, the efficacy of the NF has been evaluated in the clinical application, in the improvement and enhancement of the cognitive performances and in the emotional behavior self-regulation, which is compromised by the presence of abnormalities in prefrontal activity of low frequency oscillations. The present pilot study aims to investigate the effectiveness of a ten NF training sessions in enhancing the prefrontal activity of the delta band and the interhemispheric rebalancing associated with emotional elaborating processes, involved in a better and more functional control and regulation of emotions. In order to evaluate the efficacy of the treatment on a sample of ten healthy participants, a neurophysiological evaluation was performed observing differences in the cortical (EEG) and in the hemodynamic activity, detected by the Near-infrared Spectroscopy (NIRS) technique, during the visualization of 100 images from the International Affective Picture System (IAPS), in an earlier (T0) and later (T2) phase of treatment with NF (T1). Furthermore, the Self Assessment Manikin (SAM) scale was evaluated to assess the perceived emotional experience and the Self Report BIS/BAS scale to investigate the use of the two motivational systems underlying emotional behavior: the Behavioral Activation System (BAS) and Behavioral Inhibition System (BIS). From the results of the assessment of the perceived emotional experience, a positive correlation emerges between positive emotional assessment and the BAS and between negative emotional assessment and the BIS. From the neurophysiological assessment emerges, following treatment with NF, an increase in the concentration of oxygenated hemoglobin (O2Hb) and an enhancement and a lesser lateralization of delta activity in prefrontal areas. This study shows the efficacy of NF treatment in the enhancement of low frequency prefrontal activity and rebalancing of interhemispheric activity, enhancing the use of a multimethodic method to observe electrophysiological and hemodynamic correlates associated with emotional regulation processes and the use of NF in improving the control of their brain activity related to emotional events, useful in preventing psychological distresses and psychotic disorders that could arise in case of negative and emotionally disastrous events.

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Cerebellum and attention networks: effects of cerebellar transcranial Direct Current Stimulation on the Attention Network Test

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The functional domain of cerebellum extends beyond its traditional role in motor control. In recent years this structure has increasingly been seen as playing a crucial role also in cognitive performance and attentional processes. Attention is defined as the ability to appropriately allocate the cognitive resources to relevant stimuli. According to Posnerian model three interacting brain networks, naming alerting, orienting and executive, modulate attentive processes.
The aim of this study was to assess the possible influence of cerebellum in the functioning of the aforementioned attentive networks, using transcranial Direct Current Stimulation (tDCS) delivered over the left cerebellar hemisphere, combined with the Attention Network Test (ANT).
Fifteen healthy subjects underwent a cathodal, anodal and sham stimulation, in three separate sessions and performed the ANT task prior and after each tDCS session.
The efficiency of alerting and orienting network was similar for each tDCS sessions. Only cathodal cerebellar tDCS significantly reduced the efficiency of the executive network ($p=0.002$). After anodal and sham tDCS, a significant reduction in RT emerged for both congruent (anodal: $p=0.06$; sham: $p=0.04$) and incongruent targets (anodal: $p=0.09$; sham: $p=0.06$). After cathodal tDCS, a reduction bordering significance emerged for congruent target alone ($p=0.08$).
These results showed that only cathodal cerebellar tDCS has selectively perturbed the functioning of the executive attention network, possibly inducing a functional cerebellar inhibition. In particular, after cerebellar modulation a specific difficulty in the processing of error-conflicting stimuli occurred. We speculate that cerebellum influences the functioning of the attentive executive network both indirectly coordinating the functioning of frontal and parietal areas involved in the perception of conflicting signals and directly making predictions of errors or behaviours related to errors.

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Do different laboratory stress tasks induce specific HRV responses? Changes in Heart Rate Variability during verbal and non-verbal acute psychosocial stress tasks

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Stress is considered one of the most important risk factors for the development of cardiovascular diseases. As such, it was previously investigated in laboratory settings using different verbal or non-verbal psychosocial protocols. For example, Speech tasks focuses on the social-evaluative aspects of stress, and are considered more ecologically valid and reliable than other acute laboratory stressors, such as Stroop-Color Word task and Montreal Imaging Stress Tasks (MIST). The latter is a standardized and valid arithmetic task commonly used during fMRI studies. To date, few studies examined if there are significant differences in linear and non-linear indexes of Heart Rate Variability (HRV) between verbal (Speech and Stroop) or non-verbal (MIST) stress tasks.
We investigated the effect of three different stress tasks (Speech, MIST and Stroop) on linear and non-linear indexes of Heart Rate Variability, in a sample of 60 healthy adults (51.7% females; mean age = 25.6 ± 3.83 years). The order of presentation of the stress tasks was randomized: in addition, tasks were preceded and followed by a Baseline and a Recovery. All conditions lasted 5 minutes. A valid and reliable scale, namely the Stress Rating Questionnaire (SRQ), was used to examine the levels of perceived stress during the entire procedure (i.e. manipulation check). Raw ECG was registered through a commercially-available device; the signal was first visually inspected to correct missing and\or ectopic beats, then passed to Kubios HRV software for subsequent analyses. We used Linear Mixed Models to examine longitudinal changes in all indexes, taking into account the effect of respiration rates and the sequence order.
We found similar levels of perceived stress across the three tasks. In addition, MIST induced a stronger cardiovascular response (i.e. significantly lower levels of SDNN, High and Low frequencies of HRV, Poincaré Plot SD1 and SD2 and Correlation Dimension D2) than Speech and Stroop Color-Word tasks. Interestingly, Sample Entropy increased during the MIST, suggesting an increased irregularity of the signal. However, a visual examination of RR patterns evidenced the presence of rhythmical low frequency fluctuations in the RR time series during Speech and Stroop tasks, in comparison to MIST.
Our findings suggest that verbal activity probably masked the vagal withdrawal through altered respiration patterns imposed by speaking. We hypothesize that HRV is more strongly affected by respiration depth (i.e. tidal volume) and respiration patterns rather than the simple respiration frequency, due to fact that the latter signal was used as a covariate in all analyses. In addition, manipulation checks' and HRV's results support the use of highly-standardized math task, such as MIST, as a valid and more reliable alternative to verbal protocols during laboratory studies on stress.

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Self-other distinction of tactile states relies on S1 effective connectivity

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Touch supports processes crucial to human social behaviour, adding a bodily dimension to the perception and understanding of others' feelings. Mirroring cortical activity was proposed to underpin the interpersonal sharing of touch, allowing an automatic and unconscious simulation of others' somatic states. There is evidence that both touch processing and observation engage the primary somatosensory cortex (S1). An issue still unsolved is how our somatosensory system differentiates the tactile states from the own body from the mirror touch seen in others. Here we provide the first empirical evidence for a neural marker defining the boundary of self-other distinction of tactile states. Transcranial Magnetic Stimulation combined with Electroencephalography (TMS-EEG) recordings were performed during tactile perception and observation, looking for differences in cortical activation and connectivity between felt and seen touch. The sight of a touch directed to a human body part, but not to an object, triggered an early activation of S1 as a felt touch did, and in both conditions activity propagated to fronto-parietal regions. Critically, seen and felt touches share an effective connectivity network generated in the beta band, which is typically associated to sub-threshold, unconscious, tactile processing, while alpha band connectivity, indexing conscious tactile processing, was detected only for the felt touch. Alpha connectivity within a fronto-parietal pathway featuring somatosensory awareness represents the key to distinguish self and other's tactile states based on shared representations in S1, while the embodied facet of the others' touch appears linked to an unconscious representation of the own tactile state.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381504_bUTeUjZ9ND.jpg
Caption 1: Butterfly plots and scalp topographies of TEPs recorded in 50ms (A) and 150ms (B) SOA and (C) their difference for real touch and observed human touch

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381504_bUTeUjZ9ND.jpg
Caption 2: Experimental timeline for the A) real touch and the visual B) human and C) object touch trials.D) Neuronavigation screenshot of the TMS target over S1

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Relationship between Catechol-O-Methyltransferase (COMT) Val158Met Genetic Polymorphism, Hypnotizability, Personality Traits and Attentional Characteristics.

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Although responsiveness to hypnotic suggestions (i.e., hypnotizability) is a highly stable personality trait across time, research has shown inconclusive findings about the relationship between this trait and other personality dimensions. The stability of this construct is corroborated by neuropsychological and genetic studies suggesting that higher brain dopamine levels, depending on the lower activity of the catechol-O-methyltransferase (COMT) enzyme, might be responsible for greater attention ability in subjects with higher hypnotizability. Previous research showed a multidimensional relationship between personality traits and attentional measures with COMT. In the present study, 254 participants (201 women and 53 men) were administered the revised version of the Temperament and Character Inventory (TCI-R), the Tellegen Absorption Scale (TAS), the Differential Attentional Processes Inventory (DAPI), and the Waterloo-Stanford Group Scale of Hypnotic Suggestibility, Form C (WSGC). COMT polymorphism (parameterized as a 3-level variable: 0 = Met/Met, 1 = Val/Met, 2 = Val/Val) was assessed in 168 participants (117 women, 51 men). Hypnotizability correlated with Absorption, Extremely Focused Attention and Dual Attention for Physical-Cognitive task. Although we failed to find a significant association between COMT and Hypnotizability, we obtained that COMT correlated significantly with Novelty Seeking ($r = -.15$, $p = .049$) and its Disorderliness subscale ($r = -.21$, $p = .006$). To assess the multidimensional relationship between personality and attention measures we computed a principal component analysis. The analysis yielded four factors that respectively accounted for 31.19% (Novelty Seeking and Harm Avoidance), 19.94% (Harm Avoidance, Persistence, Moderately Focused Attention, and Dual Attention Physical-Cognitive), 18.62% (Reward Dependence, Moderately Focused Attention, and Dual Attention Cognitive-Cognitive), and 15.53% (Hypnotizability, Absorption, and Extremely Focused Attention) of the total variance. Hierarchical multiple regression analyses were separately performed in the whole sample and in women and men samples by considering the effect of the COMT, Persistence, Extremely Focused Attention and Absorption on the Disorderliness. In the whole sample COMT, Absorption, and Persistence accounted for 16.9% of the total variance. Women showed the same pattern of the whole sample explaining 18.7% of the total variance, whereas in men only Persistence reached the significant level explaining 20.2% of the total variance. The present findings challenged the dopamine-based theory of hypnosis and extended previous findings demonstrating that in the whole sample higher level of Disorderliness are associated with lower COMT activity, higher Absorption, and lower Persistence scores. These findings were also observed in women sample, but not in men sample. Further research is needed to understand gender differences, if any, in a larger male sample.

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Episodic Memory and Olfaction: is the classical paradigm, based on Encoding-Retrieval, exhaustive to investigate Olfactory Episodic Memory?

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The Episodic Memory (EM) theories have the prerogative to specify how Encoding (EN), Storage, and Retrieval (R) domains undergo aspects of memory process and to indicate which cortical areas are involved in this process. In EN and R, the neocortex areas involved are the frontal and medial-temporal lobes; specifically, the perirhinal cortex stores the aspects of EM. The anatomical connection between olfactory and memory structures makes the Smell a privileged way to study EM. The aim of this research is to investigate Olfactory Episodic Memory (OEM) by integrating an Episodic Memory Training (EMT) to EN - R phases, to evaluate if the classic EN - R paradigm is exhaustive in studying EM. 15 healthy subjects, 9 women and 6 men (mean age = 25.5, SD = ± 6) participated in the study. The experiment was divided into two phases. In the first phase, the EMT session, 2 blind vials containing odorants were entrusted to the subjects. Vials were presented in Blind condition, scilicet the vials had the same shapes, color, density and quantity of liquid, and any semantic information about the odorant. The subjects had to smell each vial twice a day for a week, in an 'ecological' environment/condition. In the second phase, during the EN, the subject performed in Lab an EEG task in which 9 of 12 smells were presented; the subject smelled each odorant for 1 minute, during an eyes-closed resting state (RS); after RS, the subject had a 1 minute of wash out. Subsequently, the subject had to perform a visual Go-No Go Task. He had to recognize the visual representation of the odorants smelled in the EN or in EMT phase. After the Go-No Go Task, the subject had to perform the R session, in which smells were re-administered in RS. ERP analysis considered Negative ERP (N1) and Late Positive Component (LPC) amplitudes in EMT, EN, and R conditions; RS analysis considered alpha values derived from the Fast Fourier Transform (FFT) in EMT, EN, and R conditions. The One Sample T Test highlighted differences in N1 and in LPC. Starting with 64 EEG channels, 14 ROIs were chosen to allow data reduction, according to the criterion of lateralization and localization. The main findings of the study are that N1 presented differences in amplitude with more negative amplitudes in the center - parietal and central area for the EN condition, and in the Temporal and Tempo-Parietal area in EP and R condition. All ROIs in the LPC showed differences in direction of a greater amplitude in EP condition. In the RS sessions, FFT analysis highlighted the higher presence of alpha in Frontal, Temporal Right, Central and Parietal ROIs in EP condition; in Parietal and Central ROIs in R condition. These results suggest that in the OEM, the integration of an Episodic Memory Training, along with encoding and retrieval processes, allows to value differences related to the Episodic Memory. These differences are discriminable in ERPs components, in EEG rhythms (i.e., alpha) and in cortical localizations.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381993_PsFLFY7C7p.jpg
Caption 1: Mapping of Encoding (up) vs EMT (center) vs Retrieval (down)

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381993_PsFLFY7C7p.jpg
Caption 2: Matching ERP -Cz - Encoding (Black Line) vs Retrieval (Red Line) vs EMT (Blue Line)

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Emotional Reactivity and Sympathetic Skin Response in Temporal Lobe Epilepsy

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Emotional and autonomic abnormal manifestations are reported by patients with Temporal Lobe Epilepsy (TLE) during the aura, critical phase as well as during the aftermath, in intercritical condition. The evidence of cognitive impairment, including the emotional domain, in TLE, is strong, Alterations in emotional processing have been related to the autonomic nervous system. The anatomy and physiology of the limbic system supports reciprocal connections between autonomic network and processing of internal and external sensory perception leading to the emotional response. The spreading activity to the limbic system with the involvement of the amygdala, hypothalamus and thalamus generates both sympathetic and parasympathetic discharges. The mechanisms of the association of autonomic function and interictal alterations of emotions remains however unknown.
The aim of the study is to investigate the relationship between emotional reactivity (ER) and autonomic response in intercritical period using well established research paradigms: the International Affective Picture System (IAPS) paradigm and Sympathetic Skin Response (SSR).
Twelve right-handed patients (4 females, 8 males, mean age 48.7 years SD 11.2) with TLE were recruited for the study. In 9 of the subjects the left temporal lobe was affected while in the other three the right one. Of these patients 6 had primary epilepsy, the remaining had an epilepsy secondary to ablation of temporal tumour. Ten healthy controls (6 females, 4 males) matched for gender and age (mean age 48.7, SD 11.2) with the clinical sample were also evaluated.
The International Affective Picture System (IAPS) paradigm consists in color pictures depicting events with different kinds of affective valence, i.e. pleasant, unpleasant, and neutral. The pleasant and unpleasant pictures were also distinguished if involving or not social human conditions.
Autonomic response was evaluated by means of the Sympathetic Skin Response (SSR) that provides a measure of sudomotor function, sensitive index of bodily arousal related to emotions. SSR was recorded from both hands, with the pictures from IAPS as externally applied arousal stimuli. Grand average of the responses was calculated for each of the five categories of pictures. Latency, amplitude and area were measured.
A comparison of the IAPS scores between the groups showed that mean arousal and valence ratings of the clinical group were significantly higher than controls for neutral and socially pleasant pictures. A trend only toward significantly higher arousal and valence of pleasant pictures was also shown. A higher valence for unpleasant pictures was observed in the TLE group. These observations were coupled with the SSR.
A link between ER and SSR abnormalities in intercritical period in TLE patients could be useful to better understand alterations of this network of highly interconnected areas as well as alterations of the behaviour.

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Model of a bionic ankle with external mechanical energy supply

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Background:
In this research work is presented a model of a biomimetic ankle prosthesis. The model proposed is able to control the pitch of the joint of ankle and, at the same time, able to control the energy recovered and its release during every single stride. The model is conceived starting from analysis of the lack of the other type of mechanical and bionic prosthesis [1]. The proposed model is able to provide to the user, thanks to an electric power motor, more power than the one recovered; this amount of power provided from the motor ensure to copy the physiological trend of torque of ankle and perform a more natural stride.
Study:
The development of the model has been articulated in 4 steps: the study of the gait of able body people, with this step it is possible to design a non-dimensional model of a lower limb in a numerical computing environment; the 2_{nd} step consist in a study of the force exchanged with a sensored treadmill in a virtual environment. Thanks to the found trends in the 2_{nd} step, in the 3_{rd} step it is designed a mechanical system able to adjust the pitch of the ankle and, at the same time, able to store and provide mechanical energy to make a complete stride; at least, the 4_{th} step, considering the prosthesis like a energy-storing-and-returning prosthesis (ESR), it is made the study of the torque and pitch of the proposed model, to identify the motion law of the motor to ensure the copy of the physiological trends (torque and angle of ankle). The mechanical system able to recover, release and produce energy, is made by a four-bar linkage (FBL) with a further fifth element which reduce the degrees of freedom (DOF) of the kinematics to 0. Two of the elements of the kinematic chain can modify their length: one is an active shock absorber that provides damping and energy storage; the other is a linear actuator, made of a screw nut mechanism, which provides pitch adjusting and energy production. The control system is based on a central control unit that detects signals from multiple sensors to determine the gait phase and position of the kinematics; the control system performs actuation to the shock absorber and to the linear actuator in order to regulate position of the foot and torque of ankle.
Conclusion:
With the proposed model it is possible to fill the gap between the ESR and the physiological ankle. Thanks to the structure of the FBL with the fifth element it is possible to exploit the DOF of the kinematic to control with only one element at the same time, the torque during the stance phase and the pitch during the swing phase. The future development consists in a study and a design of the 2 principal components of the prosthesis (active shock absorber and linear actuator) and a space and weight analysis to implement these component inside the prosthesis.
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[1] Cherelle P, Mathijssen G, et al (2014) Advances in Propulsive Bionic Feet and Their Actuation Principles. *Advances in Mechanical Engineering.*

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381933_EFGyl23enh.png
Caption 1: Torque trends comparison

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381933_EFGyl23enh.png
Caption 2: Mechanical structure of the prosthesis foot

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Impact of congenital cerebellar diseases on the representation of contextual priors during action prediction.

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Cerebellar lesions lead not only to motor disorders but to a complex pattern of cognitive, language and socio-emotional deficits referred to as “Cerebellar cognitive affective syndrome”. More recently, several studies have focused on the role of the cerebellum in event sequence detection, in generating prior models and in controlling the on-line matching between internal predictions and external information. Thus, cerebellar congenital deficits could affect the ability to form predictive prior models of other people’s behavior, limiting the understanding of others’ action goals. Here, we tested this hypothesis by comparing the action-prediction performance of infant and adolescent patients with congenital cerebellar malformations to that of a sample of age- and IQ-matched patients with congenital neurodevelopmental disorders not involving cerebellar alterations.
We used a behavioural paradigm consisting of a probabilistic learning task (familiarization phase) followed by an action prediction task (testing phase). In the familiarization phases, patients were exposed to videos showing a child actor who performed two different actions (e.g., grasping-to-eat or grasping-to-offer) associated with specific contextual cues (e.g., orange *vs* violet dish). Crucially, in this phase, the association between contextual cues and actions was implicitly biased with pre-established probability of co-occurrence (e.g., orange dish: 90% grasping to eat; 10% grasping to offer). In the testing phase, presentation of the same videos was interrupted before the hand-object contact and patients were asked to predict the final outcome of the action. Since movement kinematics was ambiguous, we expected responses to be biased toward the contextual priors acquired during the familiarization phase. Results showed that cerebellar patients were more impaired, as compared to the control patients, in predicting actions embedded in contexts with high probability. These results suggest that cerebellar alterations may cause specific impairments in the probabilistic learning of contextual predictive priors, with consequence on motor, cognitive and socio-emotional development.

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A system for motor and cognitive activities for fragile persons.

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A system is described for the administration of motor and cognitive exercises and tests to fragile persons. This system has been built in the framework of the “Intesa” project, whose objective is the implementation of services based on non-invasive ICT technologies aimed at the improvement of the life quality of elderly non-disabled fragile people, according to the guidelines given by the region of Tuscany for the identification and management of the “fragility” condition.
The system we have implemented is characterized by simplicity: it consists of portable, light (and low-cost) devices; the exercises and tests are easy and friendly and do not require any particular efforts on the part of the persons that are involved.
The hardware consists of: an EEG headset, a motion-sensing device, and a personal computer connected to the integrated database of the “Intesa” project. As regards the motion-sensing device, we have used the Microsoft “Kinect” V2 infrared-based sensor to characterize human gestures and movements. As regards the EEG headset, we have used the Interaxon “Muse” portable system for the acquisition of four EEG traces (Fp1, Fp2, TP9 e TP10) by means of dry electrodes. The mounting is quick and easy because the device is wireless and simply wearable.
The software procedures allow the motor and cognitive activities to be executed and the required measures to be performed. These activities are divided into two categories: exercises, aiming to improve the condition of the subjects, and tests, aiming to measure this condition. However, exercises are actually accompanied by measures, and tests can have a positive effect on the subjects. During the execution of the exercises and the tests, the EEG is constantly acquired by “Muse” and the movements are constantly monitored by “Kinect”.
Motor exercises are proposed by means of an avatar projected on the screen. The subject is asked to mimic the movements indicated by the avatar. Simple tasks are also proposed that are both cognitive and motor (such as connect-the-dots and select-the-tile). During these tasks reaction times and are movement precision are measured.
Procedures have been implemented for the administration of a simplified version of the classic “ANT” test for the measure of the attention level. This test consists of six patterns (a central arrow pointing at right / left with neutral / congruent / opposite direction of the flankers). The subject is asked to lift the right / left arm according to the direction of the central arrow.
The mean power of the various frequency-band activities is calculated during the administration of the “ANT” test; a statistical comparison is performed between the band powers before / during / after the visualization of the patterns. Epochs containing artifacts are automatically discarded. Possible correlations are also calculated between EEG band power variations, correctness of the responses, and reaction times.

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Modulating the Error System during the Flanker Conflict: a tACS study.

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Cognitive control is an essential requisite to prevent errors and drive efficient behavior. A crucial element of such control is the error monitoring system, which operates when conflicts between two or more alternatives occur facilitating adaptation and goal attainment in challenging circumstances. A phenomenon related to error processing is the Post-Error Slowing (PES), a conservative response mode in which behavioral slowing reduces the likelihood to commit further mistakes after error execution. EEG analysis in the time-frequency domain studies show that error processing is associated to a specific neural signature recorded from the medial frontal cortex (MFC) and named frontal midline theta (FMΘ). FMΘ increases with the request for cognitive control and may thus represent the marker of the attempt to achieve control through the synchronization of frontal structures. While studies demonstrate the correlational link between the MFC and FMΘ, no clear evidence for their causal link with error and conflict processing is currently available. In the present study, we aimed to apply transcranial Alternating Current Simulation (tACS) over the MFC exploring the role of theta activity in modulating the error system during the resolution of a modified version of the Flanker task. 36 healthy participants received tACS at different frequency bands (delta δ, theta θ, alpha α, beta β, gamma γ) and sham in a randomized controlled, within-subject design. Reaction times (msec), accuracy (% of correct answers), speed-accuracy tradeoff and post-error slowing (PES) were the dependent variables collected in the study. Moreover, after each block of stimulation, participants were asked to report any tACS-induced sensations of the following categories: *Cutaneous* (itching, heating, tingling, burning, pricking); *Visual* (flickering, flashing, bright dots); *Taste* (metal); *Physical* (fatigue, dizziness, heaviness, nausea, headache, sleepiness). The linear mixed model analysis showed a significant interaction Frequency x Post-Condition ($F(1,158.26) = 2.465$; $p= 0.035$). In particular, on the average of the least squares, the Tukey post-hoc revealed a significant difference between θ-tACS (-2.08 ± 71.59) and sham (15.33 ± 66.80; $p<0.05$) in responding to compatible stimuli following errors, with no effects for any other frequencies. Therefore, we were able to show for the first time an improvement of the post-error adaptation so as to infer about the causal relation between FMΘ, MFC and behavioral adjustment after error detection. Finally, the analysis of the tACS-induced sensations revealed that both α- and β-tACS elicited more visual and cutaneous phenomena (all $p< 0.05$) with respect to the other frequency bands. Such sensorial and perceptual effects should be taken into account when interpreting the results of the frontal cortex modulation using these bands.

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Towards immersive and multisensory Remote Operations: a Virtual reality and EEG study

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Background: Recent technological advances are now radically changing the way in which we interact with the external environment. In this vein, virtual reality not only represents an increasingly used interface but also a powerful tool to investigate human behavior and cognitive functions, in an ecological and controlled manner. However, little is known on how the sense of presence/immersion in a virtual scenario varies as a function of the environmental sensory feedback and how this affects the behavioral performance, the cognitive workload and the electrophysiological signals. **Methods:** We recorded EEG in 18 healthy volunteers trained to drive a car in a virtual track by means of a head mounted display (Fig.1). The aim of the task was to hit as more randomly appeared target (spheres) as possible (Fig.2). This task has been performed on two different difficulty level tasks (Easy, Hard) and by using four sensory input combinations, counterbalanced across the participants (Visual [V]; Visual+Audio [VA]; Visual+Audio+Vibration [VAV]; Visual+Vibration [VV]), for a total of 8 runs, 3-minute long each. In the Hard conditions, task difficulty was increased thanks to a faster appearing rate of the spheres and to the adverse environmental events (e.g. rain and mist). For each run, subjects were asked to evaluate the perceived cognitive workload using NASA TLX and the sense of presence/immersion. The Amplitude and latency changes in the ERP P300 component were used to investigate modulations of the cognitive workload. **Result:** Presence was stronger in the Hard compared to the Easy blocks; also in the Easy condition we found strong presence/immersion subjective scores only when the sensory feedback is higher (VAV) with respect to the other conditions. By contrast, in the Hard conditions the sensory feedback was beneficial for the sense of presence/immersion independently on the experimental condition, being high in all the sensory combinations (i.e., VA, VAV, VV) with respect to V. In the Hard blocks, the same pattern of results was also found for the behavioural performance. By contrast, the perceived cognitive workload decreased only in the Easy condition. Moreover, in Easy, not Hard, VAV condition induced the highest P300 amplitude, with respect to the other conditions. This result indicates a decreased cognitive workload in the stimulus processing and task performance. **Conclusions:** Overall these results confirm the idea that the sensory feedback is as an essential feature of a virtual reality environment. In fact, by facilitating the transfer of real-world knowledge and skills into the simulated context it is possible to have better behavioral performance and reduced cognitive workload, despite small differences in high/low demanding tasks. In other words, the enhancement of the sense of presence and immersion in virtual reality is a key enabler to leverage human performance, thus paving the way to remote operational application in years to come.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_386532_opwle24Be5.png
Caption 1: Figure 1. Experimental Setup

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img2_386532_opwle24Be5.png
Caption 2: Figure 2. Spherical target to hit to score points in the hard condition.

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Evaluation of attention and memory ability in migraineur children

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Background: Primary headaches are very common in the pediatric population. Many Authors demonstrate cognitive and neuropsychological disorders. The present study proposed to verify relationship between migraine and cognitive abilities.
Materials and methods: Patients were recruited consecutively into Abruzzo Regional Headache Center, Childhood Age -Dep. Child Neuropsychiatry- Hospital San Salvatore L'Aquila. Were analyzed 96 subjects of 4-17 years, 55 females and 41 males with an average age of 13 and an average onset 9 years. The sample of headache children was divided according to ICD-II and III criteria in the various types of primary headache, mostly Migraine with Aura(MA) and Migraine without Aura(MwA). Tests used for sustained attention: "AM Leiter Battery", for spatial-visual short memory: "Corsi Test" , for emotional-behavioral disorders: "CBCL".
Results: 45 children (47%) suffering from MwA and 18 children (19%) MA. From the neuropsychological data analysis, 74 children (77%) not have attention difficulties, 17 children (18%) have an attentive deficit, 4 children (4%) have both attentive and mnesic deficits and only 1 child (1%) has only mnesic deficits. 33(74%) children with MwA not have any deficiency, 10 children have an attentive deficit, 2 children have both attentive and mnesic deficits, and no child has only memory deficiency.18 children are suffering from MA , of them 13 subjects (72%) have no deficiency, 4 subjects (22%) have a deficit of attention, 1 subject (6%) has as attentive as mnesic deficits and no subject has only mnesic deficits. The sample of children with MwA(47%) did not report comorbidity with attentive and mnesic deficits. In fact is more percentage of subjects that were not affected (74%), compared to a lower percentage (26%) of subjects who instead reported that comorbidity. Into the group of MA(19%) 72% of subjects who did not have attentive and mnesic deficits compared to 28% of subjects with such deficits.
Conclusions: The Migraineur, especially migraineur with aura (MA 22% Vs MwA 18%) report a greater impairment of attentive skills and lower impairment of mnesic abilities. That occurs especially in comorbidities with Internalizing Disorders[1] .
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AUTONOMIC CORRELATES OF EMOTION REGULATION IN PATIENTS WITH PSORIASIS: A FACIAL THERMAL IMAGING STUDY

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Psoriasis is a chronic debilitating disease which is frequently associated with strong psychological distress and psychological conditions (e.g., depression, anxiety). Although some studies have indicated a relationship between this condition and difficulties in emotion regulation (as they are self-reported by the patients), behavioral and physiological evidence about this link are scarce. Here, we measured emotion regulation abilities of patients with psoriasis (N=16) and a control group (N=17) by examining the impact of distracting emotional (positive, negative or neutral) images during the performance on a working memory task ("Emotional n-back") which could present high (1 back) or low (2 back) cognitive workload. Moreover, we used Functional Infrared Thermal Imaging to record participants' facial temperature in order to obtain a measure of the activation of the autonomic system during the task. In particular, temperature over the peri-orbital areas and the tip of the nose are believed to reflect the activation of the sympathetic and parasympathetic system, respectively. Patients scored significantly higher than controls on the "Lack of emotional clarity" subscale of the Difficulties in Emotion Regulation Scale (DERS). Compared to the control group, patients showed to improve their performance when the cognitive workload was higher (and then it was easier not to pay attention to the distracting stimuli). Consistently with this behavioral pattern, patients showed lower temperature of periorbital areas (less sympathetic activation) and higher temperature of the tip of the nose (for the negative and neutral blocks) (more parasympathetic activation) in the high cognitive load condition.
These results show that Patients better regulated their sympathetic system during the high cognitive condition and suggest that people with difficulties in understanding their emotions might benefit more from the distracting power of cognitive load.

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Mirror Illusion in stroke patients with motor deficit: the role of demographic, clinical and neural factors

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Background: In the last years, the Mirror Visual Feedback (MVF) has gained increasing attention as a promising tool in neurorehabilitation. Indeed, the MVF is at the basis of the Mirror Box Therapy, a rehabilitation strategy widely used to treat motor deficit following stroke. During the therapy, patients are asked to put both arms at the two sides of a mirror placed perpendicular to their body midline, with the affected limb behind, hidden to the sight, and to perform movements observing the reflection through the mirror. This arrangement provides the illusion of watching directly the affected body part moving, favoring the retrieval of (illusory) movement sensations with beneficial effects on motor functions. While the therapeutic effects of the Mirror Box Therapy appear promising, whether and to what extent stroke patients are susceptible to reliable illusory effects is still unknown. The present study addresses this issue, by exploring the degree of susceptibility to the Mirror Box Illusion (MBI) in a group of stroke patients with motor impairment, evaluating the influence of demographic, clinical and neural factors on the MBI.
Methods: A group of stroke patients with unilateral hemispheric lesion and upper-limb hemiparesis (N=28) and a control group of neurological healthy participants (N=18) underwent to a single MVF session**.** Illusory sensations were measured through an ad-hoc self-report questionnaire, motor and sensory deficits through standardized tests, visual and motor mental imagery abilities through questionnaires. Patients' lesions were reconstructed using a template technique.
Results. The MBI is a pervasive sensorimotor experience that reliably emerges in stroke patients, as it does in healthy individuals. However, several clinical factors influence the susceptibility of stroke patients to such illusion. Firstly, the illusory effects of the MVF are linked to the integrity of motor and tactile functions: the greater the motor deficit, the less the MBI; instead, the greater the tactile deficit, the greater the MBI. Second, damage to cerebral areas involved in sensorimotor processing, self-awareness, and body representation predicted the MBI: the extension of the lesion affecting middle and superior frontal areas, the inferior parietal cortex and the precentral gyrus is positively associated to MBI, while damages to the superior parietal and postcentral regions are negatively related to the strength of the illusion.
Conclusions. Behavioural and neural factors contribute to the emergence of the MBI in stroke patients with hemiparesis: some residual motor functions are necessary to generate illusory sensations, while unreliable tactile sensation may even facilitate their emergence. Moreover, damage to low- and high-level motor areas enhanced it, while parietal lesions differentially impacted the MBI, disrupting or facilitating multisensory, body- and self-related, processing.

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Sense of Agency is more sensitive to movement execution than goal achievement

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Controlling one's own movements and the resulting outcomes in the external world generates a feeling of control, i.e. the *Sense of Agency* (SoA). The fact that unpredicted action events reduce SoA suggests that action monitoring and SoA are related. Previous studies indicate that the separate manipulation of movement execution and goal attainment may bring about profound changes of SoA. To explore how a combined manipulation of the movement and goal–related feedbacks affects SoA, we developed a novel paradigm. Thirty healthy volunteers (15 F; age, mean ± s.e.m.: 24.1 ± 0.54 years) performed simple goal-directed actions in a mixed-reality scenario. Participants laid their hand under an inclined monitor and placed the right hand index finger between two buttons. They were asked to lower or raise the finger following a color cue and to observe a virtual hand performing the same or the opposite movement where the goal (pressing the signaled color) was attained or missed. Importantly, the virtual scene could be displayed simultaneously (0 msec delay) or after various delays (75, 150, 225, 300 msec). This way we could manipulate the two action components within the same virtual scene. After each observation, participants evaluated if the observed action was synchronous or asynchronous with their own movement as a measure of SoA (judgments of correspondence, JoC). JoC are explicit judgments of agency and rely on the same information involved in attributing an action to oneself or to someone else, but they reduce the tendency to over-attribute actions to oneself. The proportion of "synchronous JoC" answers was calculated for each participant and for each condition. Mean values for each condition were entered in a 2x2x5 ANOVA with Movement, Goal and Delay as within-subjects factors. We found that perceived synchrony was reduced when participants observed an opposite movement independently of the duration of the delay, as highlighted by a main effect of factor Movement ($F(1, 29) = 4.47$, $p = .043$). Further a failure to attain the goal was associated with lower perceived synchrony, but only when the observed action was simultaneous (0 msec) or slightly asynchronous (delay = 75 ms), as revealed by a significant Goal x Delay interaction ($F(4, 116) = 4.06$, $p = .004$). Our results bring evidence that monitoring both movement execution and goal achievement modulates SoA. However, the relevance of these two action components appears to be time-dependent. While the contribution to SoA of goal monitoring is limited in time, the contribution of movement monitoring is not. This suggests a more constant contribution of movement execution over goal attainment to SoA.

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Do movements contribute to sense of body ownership?: How long-term motor practice affects Rubber Hand Illusion

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Introduction
It is still debated whether and how movements contribute to the sense of body ownership (i.e., "that body is mine"). Previous neuropsychological data suggest that absence of movements (as in patients with hemiplegia) results in more flexible body ownership, as demonstrated by stronger effects of the Rubber Hand Illusion (RHI) (Burin et al., 2015). Here, we aimed at exploring the sense of body ownership in a condition of long-term motor practice, namely, in expert piano players.

Methods
Ten expert piano players (right-handed, mean age – 24.3±8.2 years, mean years of musical expertise – 13.1±5.4) and ten control subjects without any experience in playing a musical instrument (right-handed, mean age – 23.2±1.7) participated in the vertical RHI procedure (Kalckert & Ehrsson, 2012). It included three types of RHI: *static* (the illusion was induced by touches of a paintbrush to the subjects' and fake hand's index fingers), *moving active* (subjects' movements of the index finger also caused the movements of fake hand's index finger) and *moving passive* (subjects' and fake hand's index fingers were passively moved by the co-experimenter). In all types of RHI, the procedure included the condition of synchronous and asynchronous stimulation (either touches or index finger movements were temporally congruent or incongruent between subjects' hand and the fake hand). In each condition, the strength of the illusion was measured behaviorally (perceived mislocalization of subjects' hand toward the fake hand, i.e., proprioceptive shift) and subjectively (questionnaire on sense of body ownership and sense of agency). Both left and right hands were tested. We compared proprioceptive shift and subjective ratings of ownership and agency in each type of RHI and each hand between the groups of subjects.

Results
Piano players presented significantly lower proprioceptive shift in static ($p=.05$) and active moving ($p=.01$) RHI for the right hand in comparison with the control subjects (shift in static RHI: piano players = -.63±3.10, control subjects = 2.18±3.94; shift in moving active RHI: piano players = .05±2.93, control subjects = 2.79±1.72). No differences in subjective measures of either body ownership or sense of agency between piano players and control subjects were found.

Conclusions
Our results show that piano players do not experience the illusory effects at the behavioral implicit level (proprioceptive shift). Moreover, they least experience the illusion in the condition with active movements. Since during the RHI, the initial conflict between visual and proprioceptive information is typically resolved in favor of vision (which results in the embodiment of the fake hand), it is possible to suggest that increased motor activity, and therefore, higher amount of motor-related signals, enhances the input of proprioception in body ownership.

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Dependent or independent? The role of working memory in prospective memory.

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Prospective memory (PM) refers to the processes associated with the planning and execution of delayed intentions. PM involves a complex balance between the memory of an intention and the maintenance of concurrent activities, thus requiring different cognitive mechanisms. Recent studies have examined the involvement of WM in the PM in order to investigate whether these two processes share cognitive resources or they are independent mechanisms. It was shown that PM is supported by the central executive component of working memory (WM), which organizes the execution of joined actions through selection of relevant information and suppression of the irrelevant ones. According to the preparatory attention and memory model (PAM), PM task performance is always influenced by the availability of WM resources, since controlled attentional processes are needed. Differently, the multiprocess framework posits that a delayed intention can be automatically retrieve, at least under certain circumstances, suggesting that PM and WM are distinct mechanisms.This study aims to examine the role of WM in PM, by comparing the performance of MB, a patient with a disexecutive syndrome and proved PM difficulties acquired after brain damage, to that of nine healthy participants. Two experiments were developed, in which subjects had to perform an ongoing activity together with a PM switching task. We administered two distinct ongoing tasks for the Experiments, differing for the amount of cognitive resources required: a simple arithmetic (Experiment 1) and a high-load WM task (PASAT test, Experiment 2). As a further variable, the modality of PM retrieval was manipulated by introducing both time and event-based conditions for each experiments. In the time-based conditions, the PM task had to be performed at a given time, whereas in the event-based condition PM retrieval occurred following cue presentation. MB's performances in PM tasks significantly differ from the controls only in the PASAT time-based condition. By the comparison of Experiment 1 and Experiment 2 results in time and event-based conditions, significant differences also arose in the effect size between MB and healthy subjects, which were selective for time-based conditions.Our results indicated that WM has an influential role on PM performance only in complex tasks when active self-retrieval is required (PASAT-time), suggesting that PM and WM are partially independent. Such findings provided support to the multiprocess framework, highlighting how WM and PM can be considered as distinct mechanisms at least when the prospective retrieval is associated with a cue (event-based conditions). Moreover, they emphasized PM as a complex high-level metacognitive function, which requires coordination of future intentions through adoption of strategic and controlled processes.

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TDCS-induced changes in physiological and pathological brain aging: a TMS-EEG study.

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Synaptic dysfunctions, with consequent neuroplasticity alterations, have been proposed as a cause of physiological and pathological cognitive decline. To identify neurophysiological markers of neuroplasticity changes on the cortical areas firstly impacted by aging and Alzheimer's Disease (AD), i.e. prefrontal cortex, could allow not only to understand the mechanisms underlying the cognitive impairment but also to provide new insight into how neuro-modulation protocols could drive neuroplasticity. In this framework, our study aimed to investigate how the neuroplasticity mechanisms, both at cortical and behavioral level, are affected by physiological and pathological aging. We used transcranial direct current stimulation (tDCS) as neuro-modulation technique over prefrontal cortex. TMS-EEG recordings and a working memory task were performed to monitor the tDCS polarity-dependent effects on cortical and behavioral measures, respectively. Twelve healthy young and elderly subjects, and ten AD patients received anodal, cathodal and sham tDCS over the left dorsolateral prefrontal cortex, in three separate sessions, in a counterbalanced order. Before and after tDCS, a verbal n-back task was performed, with different difficulty for each group. Accuracy rate and reaction times were evaluated in task performance. Combining TMS-EEG during resting state, the cortical reactivity was assessed over prefrontal cortex. Interesting tDCS polarity-dependent changes were observed in task performance although they did not reach the statistical significance. Nevertheless, tDCS polarity-dependent cortical changes were observed among the groups. Specifically, a cortical reactivity increase after cathodal and a decrease after anodal tDCS in young subjects were observed, whereas opposite cortical patterns were found in elderly subjects, with a cortical reactivity increase after anodal and a decrease after cathodal tDCS. Finally, a decreased cortical reactivity after both anodal and cathodal tDCS was observed in AD patients. Our findings demonstrate that tDCS is able to induce prefrontal cortical reactivity changes, which can be assessed by TMS-EEG measures, even if behavioral data were not sensitive enough to reveal functional modifications. Importantly, we observed that the polarity-dependent effects induced by tDCS are not linear during the life span and substantially change with pathological aging. For the first time, we have demonstrated that measuring cortical plasticity in physiological and pathological aging may provide early neurophysiological markers of cognitive decline. Moreover, these modulations shed clues to establish more effective neuro-modulation strategies.

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Transcutaneous Vagus Nerve Stimulation reduces implicit spiritual, but not religious, self-representations

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Religiousness and spirituality are universal phenomena in which individuals tend to detach from the representation of the bodily Self in space and time and alter the sense of boundaries with others. Previous evidence showed that the vagal tone, which is an index of parasympathetic activity, is associated with the activation of religious and spiritual self-representations. Moreover, spirituality is a predictor of autonomic control. However, in healthyhumansit has not yet been demonstrated whether directly manipulating vagal tone alters religiousness and spirituality and whether these two aspects of human life, which are supposed to be mediated by different neurocognitive mechanisms and related todifferentweighting of exteroceptive and interoceptive information, are differently associatedtovagal tone. To explore these issues, we used transcutaneous vagus nerve stimulation (tVNS), a novel non-invasive brain stimulation technique that stimulates the vagus nerve via the application of a mild electrical stimulation to its auricular branch. We assessed the effects oftVNSon explicit and implicit Religious and Spiritual representations as compared to control Self-Esteem ones. Explicit Religious and Spiritual representations were measured, respectively,throughthe Index of Core Spiritual Experiences questionnaire and the Self-Transcendence scale of the Temperament and Character Inventory. Implicit representations were tested by means of i) Religious, ii) Spiritual and iii) Self-esteem Implicit Association Tests. Our results showed that active-tVNS, compared to sham-tVNS, affected implicit spiritual, but not religious or control self-esteem self-representations, by reducing the strength of the automatic association between the Self and the spiritual dimension. All explicit self-representations were left unchanged. We propose that the reduction of implicit spiritual self-representations reflects the strengthening of the representation of the bodily Self following the boosting of interoceptive signals mediated by the autonomic nervous system and related cortical and subcortical areas. Our findings support the notion that the autonomic nervous system controlling the vagal tone is causally involved in implicit spirituality, independently from the specific aspects of faith traditions associated to religiousness or from non-specific processes related to the representation of the Self.

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Does the observation of an action inserted in an emotion-enriched context influence cortical excitability in patients with Parkinson's disease?

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Observing other people in action activates the “mirror neuron system” that serves for action comprehension and prediction. Recent evidence suggests that this function requires a high level codification triggered not only by components of motor behavior, but also by the environment where the action is embedded. An overlooked component of action perceiving is the one related to the emotional information provided by the context where the observed action takes place. In particular, a recent study showed that, in healthy young subjects, cortical excitability increases when subjects observe a grasping movement inserted in a disgusting context, compared to a sad or a neutral context. Parkinson’s disease (PD) is a neurodegenerative disease which causes deficits in the motor system due to dysfunctions in basal ganglia circuitry and nigro-striatal pathways. Recent studies showed that emotions play an important role in influencing some PD symptoms, like freezing of gait. The aim of the study was to explore the effect induced by the observation of a grasping movement, inserted in different emotional contexts, on cortico-spinal excitability, in healthy elderly people and in patients with Parkinson’s disease. Cortico-spinal excitability of the left hemisphere was recorded while participants were watching the same grasping movement embedded in contexts eliciting disgust and sadness and a neutral context. Moreover, in all participants affective Theory of Mind has been evaluated, in order to explore their ability to recognize others’ emotions and feelings and to study its potential connection with motor behaviors. At this purpose, the Reading the Mind in the Eyes test (RMET) has been used. Results showed that in healthy subjects a greater increase of cortical excitability was present only during the observation of the hand moving in a context eliciting disgust, with respect to a context eliciting sadness or a neutral one. No influence of the emotional context was observed in subjects with Parkinson’s disease. Moreover, participants who performed better in the RMET showed a great increase of cortical excitability when observing the grasping movement in the disgusting context. Results could support the hypothesis of a damage in neural circuits involved in emotion recognition and their connections with motor circuits in Parkinson’s disease.

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Gait initiation is influenced by emotion processing in Parkinson's disease patients with Freezing.

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Freezing of gait is a symptom that affects over 50% of Parkinson's disease (PD) patients and increasing evidence suggests that non-motor systems (i.e., limbic system) are involved in its underlying mechanisms. The aim of the study was to investigate whether gait initiation characteristics are influenced by emotional stimuli in patients with PD, with or without freezing of gait.
Forty-four participants, divided into three groups (15 PD patients with freezing of gait, 15 PD patients without freezing of gait and 14 controls), stood on a sensorized mat and were asked to take a step forward when a pleasant image appeared on a screen and a step backward in response to an unpleasant image (congruent task) or to take a step backward in response to a pleasant image and a step forward in response to an unpleasant image (incongruent task). Reaction time, step size, anticipatory postural adjustments and sway path in the first 400 ms after stimulus presentation were measured. Results showed that in PD with freezing of gait the reaction time was longer and the step size was shorter than in the other groups when they took a step forward in response to an unpleasant image (incongruent task). Further, changes in reaction time performance in response to unpleasant images positively correlated with the "frequency" of freezing episodes. This study demonstrates that gait initiation was influenced by the emotional valence of visual stimuli suggesting that the limbic system may be involved in freezing of gait and offers speculations to novel therapeutic approach.

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Impairment of motor and behavioral inhibitory control in Parkinson's disease patients with levodopa induced dyskinesias

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Chronic dopamine replacement therapies in Parkinson's disease can induce side effects, among which the most common are levodopa-induced dyskinesias (LID) and impulse control disorders (ICD). A dysfunction of inhibitory brain networks has been linked at the basis of these disorders; however, there is no behavioral evidence supporting this hypothesis. Aim of the current study was to determine whether PD patients with LID show features of altered motor inhibition in parallel with increased impulsivity when compared to PD patients without LID and healthy subjects. We also investigated the effects of levodopa intake on reactive and proactive motor inhibitory performance in PD patients. Two matched samples of PD patients with (n=10) or without (n=10) LID and a control group (n=10) participated in the study. All groups were evaluated by the Barratt Impulsiveness Scale-11 (BIS-11) to assess impulsivity traits. Furthermore, all participants performed a stop-signal task (SST) to evaluate reactive-motor-inhibition and a Go/NoGo task to evaluate proactive- inhibitory-control. PD patients were tested both following a night of levodopa withdrawal (OFF condition) and under the effect of levodopa medication (ON condition).
PD patients with LID showed higher impulsivity scores than PD patients without LID. Dyskinetic patients presented also delayed stop signal reaction times indicating a worse performance in reactive-inhibition. A positive correlation was found between the slowness in inhibiting a motor command and the impulsiveness scores. Farther, in the dyskinetic group a positive correlation was found between stop reaction times and the severity of involuntary movements. No difference among groups emerged to the Go/NoGo task. However, under the effect of levodopa all patients were faster and dyskinetic patients were significantly less accurate.
Thus, reactive- but not proactive inhibitory-control resulted compromised in dyskinetic patients in parallel with increased impulsivity, showing an impairment of motor and behavioral inhibitory control in Parkinson's disease patients with LID. Levodopa can selectively modulate proactive motor control, especially in presence of LID. The occurrence of high impulsivity scores and deficits in reactive-motor-inhibition, selectively found in dyskinetic patients, indicates levodopa-induced-dyskinesia as a symptom of a wider behavioral disinhibitory condition.

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Interhemispheric imbalance in stroke patients: a new TMS/EEG cortical marker

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Unimanual voluntary actions are crucially regulated by mechanisms of interhemispheric inhibition (IHI). In patients with stroke, a reduction of the inhibition exerted by the stroke-affected hemisphere (AH) onto the unaffected hemisphere (UH) is thought to play a role in contrasting a successful recovery. Such unbalance in IHI could limit the gains in motor recovery that can be achieved through rehabilitation. So far IHI has been investigated only by measuring changes of motor-evoked potentials (MEPs) using bifocal transcranial magnetic stimulation (TMS). However, these methods are limited by the fact that in a high percentage of stroke patients MEPs cannot be reliably measured due to the underling damage of the corticospinal tract. In this study we used a novel combined method of TMS and electroencephalography (EEG) to investigate mechanisms of interhemispheric connectivity in a sample of stroke patients tested in the chronic stage of recovery.
18 patients in the chronic stage of recovery (i.e. at least 6 months after stroke), with first ever-ischemic stroke in the territory of middle cerebral artery (7F, 11M; age 61.8±10.8 years) were recruited. The patients underwent a structural MRI scan and a TMS-EEG mapping over the primary motor area (M1) of both the AH and UH hemisphere. Patients were compared to a group of 10 age-matched healthy volunteers stimulated in the same areas of both the hemispheres. We computed the TMS-evoked signal propagation (SP), as a measure of IHI, and the M1-M1 spectral coherence, as a measure of interhemispheric connectivity.
We found a strong interhemispheric imbalance in SP of stroke patients [$F(1,27)=13.471$; $p=0.001$]. When stimulating the AH-M1, SP was highly variable among the patients without a clear spatiotemporal dynamic (post-hoc $p=0.387$, Bonferroni corrected). When stimulating the UH-M1, SP was reduced in 16 of 18 patients (post-hoc $p<0.001$, Bonferroni corrected) similarly to what occurred in healthy volunteers (post-hoc $p<0.001$, Bonferroni corrected). Correlation analysis showed that patients with higher corpus callosum volume showed lower SP (i.e. stronger IHI) after UH stimulation ($r=-0.733$; $p<0.05$) and higher spectral coherence between the two M1s ($r=0.664$; $p<0.05$). No significant correlations were observed after AH stimulation.
Our results demonstrate that (1) IHI is preserved when stimulating the unaffected hemisphere of stroke patients; (2) IHI is enhanced in patients who showed a stronger M1-M1 connectivity and higher volume of the corpus callosum; (3) TMS-EEG SP is a reliable and quantifiable cortical marker of the presence of an IHI imbalance. From a clinical point of view, our finding could be useful to predict the degree of motor recovery achievable by stroke rehabilitation; from a methodological point of view, we provide a quantifiable and reliable index to non-invasively assess the interhemispheric dynamics.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_382035_T2b2P6AqiI.png
Caption 1: (A) interhemispheric inhibition in controls and stroke patients (B,C) correlations between corpus callosum volume and TMS-EEG measures

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_382035_T2b2P6AqiI.png
Caption 2: TMS signal propagation in controls and in stroke patients stimulating the affected (AH) and unaffected hemisphere (UH)

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The effect of age and cognitive load on brain neurofunctional lateralization: A tDCS study

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Neuroimaging studies suggest that brain aging is characterized by a reduction of hemispheric lateralization while performing tasks that require the use of complex cognitive functions. Recently, some authors propose that also young people show bilateral neural activations as task demand increase, reflecting a compensation process that characterize brain during our lifespan.
In most studies, however, task difficulty has been manipulated in a static and pre-specified way, regardless of the individual cognitive resources.
In the present study we investigate changes in neuro-functional lateralization due to increasing subjective cognitive load in 24 young and 16 older participants performing a digit span backward (DSB) and a paced finger tapping task (pFT).
We used tDCS to assess each hemisphere involvement in task performance and, in contrast with previous literature, we implemented a new paradigm based on a pre-experimental assessment to set up for subjective levels of cognitive loads.
In the pre-experimental session, participants performed each task starting from the lowest level of task difficulty to the level at which they were no longer able to perform any trial correctly. This procedure allowed us to determine, for each participant and task, 3 different levels of subjective task demand: low (5/5 correct answers), medium (3/5) and high (1/5).
During the experimental session, participants performed each task at their subjective levels of task demand during 3 tDCS sessions, counterbalanced for order: two anodal conditions (left and right hemisphere) and a sham/placebo one. TDCS (20 min, 1.5 mA) was applied through a target electrode (5x5 cm) positioned to stimulate both the inferior frontal gyrus and the primary motor area.
A 3 (type of stimulation: left, right, sham) x 3 (subjective cognitive load: low, medium, high) mixed model analysis with random by-subject intercept was run within each group.
For the young group, a significant interaction between type of stimulation and subjective cognitive load was found for the reaction times recorded during the DSB and for the number of correct responses tapped in each trial's pace-constrained time window in the pFT: for the most demanding condition, right anodal tDCS significantly interferes with behavioral performance.
The preliminary results obtained from the 16 elderlies suggest instead that tDCS influences performance only for the "easy" and "medium" conditions.
Our results support the hypothesis that hemispheric lateralization is influenced by the subjective level of difficulty of the task. Our findings are also consistent with the hypothesis of a limited reserve of cognitive resources. The study provides data relevant for the recent debate on the neurocognitive models of aging.

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Modulation of HBR reflex during movement illusion

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The Hand Blink Reflex (HBR) is a subcortical defensive response, elicited by the electrical stimulation of the median nerve at the wrist. HBR responses dramatically increased when the stimulated hand move inside the defensive peripersonal-space (DPPS) of the face, no matter what kind of movement (voluntary, passive or imagined).
We aim to investigate whether the kinesthetic illusion of movement could modulate the HBR responses like other dynamic conditions.
In 8 healthy subjects that shows reproducible HBR responses both in static that in dynamic conditions, we evoked the illusion of movement by vibrating biceps and triceps of the right arm to induce, respectively, the sensation to move the forearm down, far from the face and up, towards the face. Electromyographic activity was recorded from the orbicularis oculi while the HBR response was elicited: in three starting hand positions, depending on the distance of the hand from the face (far, intermediate and near positions); in two vibrating condition, before the onset and after the illusion started.
Results showed that HBR responses elicited during the illusion of the movement increased with respect to them elicited during the vibration, but before the illusion. Also, HBR increased during the illusion of the movement toward to the face, with respect to the movement in the opposite direction. However, this modulation did not depend by the starting position of the hand.
Our data could provide information about the neural mechanism that potentially modulates HBR: one related to the proprioceptive integration before movement illusion, the other responsible of the definition of a new body schema induced by illusion.

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Facial mimicry and neuromarketing: neurophysiological effects of advertising on audience

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Nowadays advertising is always more often interacting with the consumer, reducing the distance between virtual and real space. The present study investigates how facial expressions in commercials can influence the comprehension and the ability to remember spots, brands and products publicized. Nineteen subjects (10 female and 9 male; mean age 21,4) were involved in the vision of a set of stimuli of advertising that were emotionally connoted by positive, negative or neutral valence based on the facial expression of actors involved in the advertising. Advertising stimuli with different emotional valence belong to the commercial categories of food supply and health, where food and medicines were presented. Every video was evaluated with the adjectives of a semantic differential and the SAM scale (Self-Assessment Manikin Scale). During the experiment, cortical activity was recorded with EEG (Electroencephalography), while physiological measures and ocular movements were gathered by biofeedback and eyetracker. A questionnaire to evaluate the brand andproduct recall was administered at the end of the experiment. Eye movement analysis confirmed that sample attention was significantly captured by faces that appeared in the showedvideos. Moreover, data revealed a difference in subjects'autonomic activity relatively to videos valence and advertising category. In particular, there was an increase in the heart beat and in the zygomaticus major muscle activity during the vision of advertising related to food with a positive valence. The same activity was found for the health category, but related to advertising with negative valence. It may seem that a dissonance between facial expression positivity and the related category was perceived. It is possible that there was a prevalence of a semantic process over a mirroring mechanism, in fact, electrophysiological data suggested that positive video processing should be due to the dissonant contest in contrast with the emotion showed in the video and not to the facial expression by itself. Indeed theta band values was greater in right frontal area for health category instead of food. According to the literature the right hemisphere is involved in the negative stimuli processing. EEG and autonomic results were in line with the final questionnaire in which negative valence advertising related to health is the category less recalled between the others. Overall, it seems that these data could be interesting not only to suggest advertising producers the most effective strategy to persuade consumers, but also to sensitize the audience to a more critical purchase.

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Social and commercial advertising: a Neuromarketing study

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This study aims to investigate neurophysiological activation during different types of multimedial artefact fruition. In particular we want to verify cortical activation during the vision of both social issues and commercial advertising videos. 10 videos of 30 seconds of duration are presented to a sample of 15 healthy subjects. Advertising videos are selected identifying 5 categories comparable by a commercial or pro-social point of view, and they were: money, health, technology, nutrition and clothing. During videos vision, cortical and physiological activation are recorded by electroencephalography (EEG) and biofeedback. EEG data show a tendency in the presence of Alpha in central areas for social advertising in comparison with commercial advertising and in general there is more activation in the right hemisphere considering that the value of alpha is higher in the left hemisphere, especially in the categories health, money and clothes. This right activation suggest that health, money and clothes are not prerceived as positive. These findings are supported by the results of the semantic differential in which the commercial advertising was considered less accessible, and specially the category money, was considered less desirable, prestigious and new. Also the presence of theta is related with emotions and considering that was higher in frontal area, it is related with high level mental functions such as motivation, control of behavior, emotions and acts in the ethical and moral sense. It is possible to suppose that social advertising (that has higher presence of theta in frontal areas) brings the activation of brain areas related with altruistic behavior. This is also supported by the results of semantic differential in which social advertising was considered more useful. The autonomic indices PVA (Pulse Volume Amplitude) reports a higher activation during social advertising, that suggests that this type of advertising provokes a greater emotional response (according to theta band levels in social advertising). Pulsations increase in the category health and clothes for social advertising, while they increase in the category food and technology during commercial advertising. It is possible that social advertising is the type of advertising that most activate emotional responses, for that reason, it is possible to conclude that advertising with social content activates brain areas related with altruist attitude and areas related to emotions.

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Synchronizing autonomic response. A biofeedback hyperscanning approach to assess emotional tuning

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Existing research already suggested that during different types of social interaction people can reciprocally influence others' emotional responses through resonance mechanisms. One of the most interesting aspects from a neuroscientific point of view is that such tuning mechanisms can result in an alignment of the psychophysiological responses. In detail, the peripheral autonomic activity is particularly sensitive to interactive social dynamics and it has been demonstrated that the presence of a link between two or more individuals can modify their psychophysiological responses by creating synchronized patterns. Starting from the idea that, when two individuals have a common goal, they also share emotional experiences, the present study adopted a new paradigm which was created to artificially induce a social bond. The experiment consists in asking participants to cooperate each other and monitoring their peripheral indices in real-time according to the perceived emotional closeness. The paradigm was presented as a game and consisted in a selective attention task. 24 participants, coupled in same-sex dyads, participated in the study. Instead of being required to perform as best as they could, they were asked to find a way to synchronize their motor responses and obtain comparable reaction times and accuracy rates. Both electrodermal (electrodermal: skin conductance level and response: SCL, SCR) and cardiovascular indices (heart rate: HR) were recorded continuously throughout the task. To induce participants to cooperate and to be engaged in the joint task, a general feedback was presented halfway assessing a positive cooperative performance. Such feedback was pre-determined by the experimenter. Two successive steps of analysis have been performed. The first one was at the subject level and was meant to explore the general modulation of peripheral indices during the different phases throughout the task. Results showed that the first part of the task was characterized by higher HR activities. It is possible to attribute such result to the increased need for cognitive resources and arousal-related responses in a new social context which must be still acquired and organized. On the contrary, after the social feedback and the acquisition of confidence and positive emotions coming from the joint performance, such indices significantly decreased. Then, a second analysis was performed on the correlational indices calculated between the psychophysiological responses of the two members of each couple. This procedure showed increased synchrony in electrodermal activity after the social feedback, moreover in the very last phase of the game. Such result can be attributed to the reinforce of common strategy and, above all, of a dyadic bond. This new paradigm thus proved to be useful to explore joint and ecological social dynamics in neuroscientific settings and future research could include it to explore such dynamics also in clinical settings.

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Child-animal interactions: how species influences emotion perception

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It has been highlighted that animals are more and more present in our everyday life, especially when speaking about children, and many previous studies demonstrated the positive effects of child-animal interactions. This new theme is attracting increasing attention by the scientific community, thus leading to the formulation of some theoretical positions about inter-species relationships. For example, it has been shown that children show an innate interest in animals and a propensity to approach them. Even in the very first months of life they exhibit a visual preference for videos representing animals than other animated subjects. Nonetheless, scientific evidence is still missing with respect to the emotional and neural substrates of human-animal interactions, and should take into account the psychological level. To do so, the present study involved the participation of 34 children who were asked to passively view affective pictures depicting both child-child (CC) and child-animal interactions (CA) while their electrocortical activity (EEG) was monitored and recorded. Results showed increased delta activity while viewing CA stimuli. Such effect was also characterized by a lateralization pattern over frontal sites, with increased left-lateralized responses for positive pictures and right-lateralized responses for neutral ones. Considering the functional role of this frequency band, related to both attentional and emotional mechanisms, it is possible to assume that such stimuli did trigger both processes. For what concerns high-frequency bands, instead, increased beta (higher power) and alpha (decreased power) activity emerged during CA stimulation. Also in this case a lateralization effect emerged over fronto-central sites, with left-sided responses for positive pictures and right-sided responses for negative ones. Since lateralized patterns involving alpha band have been often explored for affective processes, it could be hypothesized that this kind of stimuli are highly connoted from an emotional point of view. Finally, considering gamma band, an increased activity emerged for CA animals, but only for negatively valenced ones. Gamma band is associated with complex cognitive processes related to integrative mechanisms and problem-solving. Considering children's natural propensity to approach animals, the vision of negative scenarios depicting aggressive individuals could create an incongruent response. The preliminary results obtained in the present study suggest the importance of a systematic study on the neurophysiological correlates of human-animal interactions with respect to intra- and inter-species contexts, to assess similarities and specificities from an evolutionary point of view.

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Brain@home: cognitive exercises for an active healthy aging. (Project Brain@Home - AAL 2015)

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During normal aging, neuroanatomical and neurophysiological modifications occur, accounting for alteration in cognitive functions. Age-related cognitive deficit may interfere with everyday life, leading to difficulties to cope with different tasks and situations. Cognitive training may induce neuroplastic changes in the brain through structured practice on standardized tasks, leading to enhancement of cognitive abilities, also in elders. Computerized Cognitive Trainings (CCTs) have a positive effect on cognition (Lampit et al., 2014) and multidomain CCT lead to increase hippocampal functional connectivity (ten Brinke et al., 2017). Recent studies have implemented Virtual Reality (VR) with rehabilitation and training uses, given that such systems have interactive therapeutic possibilities. Evidences support the role of VR in the improvement of cognitive abilities in clinical populations, such as increased memory skills in older adults with memory deficits (Optale et al. 2010). The goal of the present study is to evaluate the effect of a multidomain home-based CCT using VR on Quality of Life (QoL) and cognition in healthy older adults. A multicenter (Italy, Romania, and Hungary) single-blinded RCT will be adopted. 120 elderly subjects (aged between 60-80 years) without neurological, cognitive, psychiatric or acute disorders will be recruited and randomly allocated to the experimental (N=60) or control group (N=60). The experimental group (EG) will engage in a CCT combining VR navigation and serious games. Participants will access to an online platform by means of a tablet. In each training session, participants will navigate in engaging VR environments of interesting cultural sites and will ecologically have access to serious games focused on stimulation of attention, memory and executive functions. Given that CCT efficacy was largely determined by design choices such as training administration (delivered in clinical setting with the presence of the trainer, “group-based” or “home-based”), our study will combine an initial group-based phase with a following continuation of the intervention at home. Moreover, a constant remote clinical supervision will ensure interactions and support to participants. The control group (CG) will access to several educational contents, with the same device of the EG. Both groups will perform 3 sessions per week of 45 minutes each, for a total of 12 weeks. Both EG and CG participants will be assessed with measures of QoL (primary outcome), cognition and social engagement (secondary outcomes) at baseline, immediately after the training and after one month follow-up. We expect to find improvements in cognitive outcomes and increased levels of subjective wellbeing and social engagement in the EG as compared to the CG, due to the involvement in a structured CCT combining engaging VR environments and challenging tasks, which may promote an active aging and increased self-awareness of cognitive abilities in healthy elderly.

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From Biochemistry to Behaviour through Brain: right dACC activity is modulated by B12 levels and predicts visuo-spatial abilities in MCI and healthy subjects

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Growing evidence is showing the involvement of different blood biomarkers as risk factors for dementia and cognitive impairment. Homocysteine (tHcy), vitamin B_{12} and folate have been consistently associated to pivotal neurodegenerative mechanisms[1]. Consistent results from different cross-sectional and longitudinal studies support the association between elevated plasma tHcy, vitamin B_{12} and folate levels and structural properties of the brain. Higher tHcy levels are directly associated to the magnitude of global and hippocampal cortical atrophy[1], while folate levels to the severity of global atrophy in Alzheimer's Disease patients[2]. In sharp contrast with the abundance of studies indicating a strong relationship between biochemical markers and brain morphology, whether serum tHcy, vitamin B_{12} and folate levels - as well as their interactions - affect the elders' brain activity had still to be determined. Thus, we measured the relationship between brain response during a visuo-spatial attention task and biomarkers level in a group of sixty-five non-demented elders with a cognitive status spanning from normal to Mild Cognitive Impairment (30 M; mean age ± standard deviation: 74 ± 5 years; education: 10 ± 5 years; Mini Mental State Examination scores: 25.9 ± 2.0). The roles of brain regions modulated by homocysteine, vitamin B_{12} and folate, were tested as predictors of subjects' cognitive status, measured through an independent neuropsychological assessment. We did so by means of a Principal Component (PC) analysis, that led to 17 uncorrelated dimensions. Task-evoked activity of the right dorsal anterior cingulate cortex (dACC), a crucial node of the salience network, was positively correlated (p-value < 0.05 cluster-corrected) with vitamin B_{12} concentrations (r = 0.52), so that elders with higher B_{12} levels had a more pronounced recruitment of this region. The response of dACC was also able to act as a predictor of subjects' visual search and attention abilities (Fig. 1; r = 0.39, p-value = 0.0023), measured by the Trail Making Test-A (11^{th} PC). The same prediction was not possible when simply considering vitamin B_{12} levels, indicating the role of dACC activity as necessary to unveil the relationship between biochemical markers and cognitive status. This study was the first to investigate whether brain characteristics mediated by biomarkers serum concentrations can act as an endophenotype in predicting single subject cognitive status. Our finding indeed supports the necessary role of the right dACC, significantly modulated by vitamin B_{12}, in the prediction of non-demented elders' spatial attention and visual search abilities.

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Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_385449_hoHwPGTTwW.jpg

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Effects of cerebellar theta burst stimulation on visuomotor adaptation task in a group of chronic ischemic stroke patients

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Objectives
Stroke is characterizing by deterioration of motor functions. Although in normal conditions motor adaptation corrects for movements' inaccuracies and as such it is critical in maintaining optimal motor control, in stroke disease motor adaptation is impaired. In the past years, non-invasive brain stimulation methods have shown the potential to modulate brain plasticity in humans. In particular, repetitive transcranial magnetic stimulation (rTMS) can be used to enhance adaptive processes and prevent those potentially maladaptive in stroke recovery. In our study, we aim to investigate the effects of cerebellar transcranial magnetic stimulation (TMS) for modulating visuomotor adaptation performance in chronic ischemic stroke patients in order to assess physiological mechanisms underlying motor learning processes.
Materials
Ten patients with chronic subcortical ischemic stroke were enrolled in a controlled, randomized cross-over design study.
Method
All participants performed, with the affected hand, a visuomotor adaptation task (VAT) and received an intermittent theta burst stimulation (iTBS) over contralesional cerebellum. All patients were evaluated in two different sessions (real *versus* sham) at the same hour in the morning at one week apart. Behavioral testing was divided into four phases: baseline, learning, consolidation (after a break of about 45 minutes) and de-adaptation. During the baseline and the de-adaptation phases, the direction of movement of cursor (target) matched the movement of the joystick. During learning and consolidation phases, the movement of the cursor was rotated clockwise/counter clockwise by 30 degrees relative to the joystick movement. Cerebellar iTBS was performed between baseline and learning phases.
Results
Our data showed that iTBS applied over the contralesional cerebellum increased the ability to adapt to the angular perturbation in comparison to sham condition. No difference among groups (real *versus* sham) was found at baseline and de- adaptation phases.
Discussion
These findings provide more evidence supporting that cerebellar iTBS is able to modulate motor adaptation performance in chronic ischemic stroke patients, increasing their ability to adapt to the angular perturbation.
Conclusion
Cerebellar stimulation is an interesting approach to better understand the cerebellar neurophysiological mechanisms underlying motor learning processes. Moreover, it may have the potential to become a therapeutic intervention to improve motor function in stroke patients.

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Categorical perception of ethnicity: a neuroconstructivist perspective.

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Perceptual categorization (PC) is a domain-general process allowing a quick distinction and classification of sensory stimuli as belonging to same (within-category, WC) or different (between-category, BC) categories. Electrophysiological studies clearly indicated in the visual Mismatch Negativity (vMMN) a reliable event-related potential (ERP) signature of PC. Recent studies have shown that PC can operate in the social domain as a mechanism allowing to cluster people into same ethnic groups. In the current study we investigated the neural underpinnings of PC in adults and pre-schoolers children passively presented with either WC or BC ethnic faces with the aim of unveiling the developmental trajectories of brain activity underlying both face perception and PC.
Twenty adults and nineteen pre-school children (3 to 5 year-old) were passively presented with a multi-feature visual oddball paradigm while watching a black and white cartoon movie. Stimuli consisted of bilateral pictures of neutral faces (i.e., either Caucasian or Asiatic). In the standard condition (50%) both left and right faces featured same ethnicity. In the two deviant conditions the left or the right face could be replaced with a morphed face showing same (WC; 25%) or other (BC; 25%) ethnicity. High-spatial resolution EEG activity was collected during the whole task with the aim of investigating the effect of age on both N170 and vMMN as markers of face perception and PC, respectively. The brain source reconstruction of significant ERP effects was also performed.
ERP analyses showed that the face-sensitive N170 component was overall earlier and smaller in adults as compared to children, but only in the latter group this component was correlated to age. Specifically, it became earlier with age increasing, in line with a maturational account. No PC effects were found on the N170, which was identical for standard and deviant conditions. Unlike, PC affected vMMN amplitude following the N170, since it exhibited larger amplitude following BC than WC deviant faces. Interestingly, this effect was stronger in children than adults. Correlational analyses further showed that N170 latency and amplitude predicted the magnitude of the PC effect. Brain source analysis revealed developmental differences in the vMMN cortical generators, which were functionally localized in circumscribed portions of the left temporal lobe (i.e., fusiform gyrus and superior temporal sulcus) in adults and in a diffuse fronto-temporal network (i.e., prefrontal cortex and temporo-parietal junction) in children.
Our data confirm that the PC for ethnicity is well established in pre-schoolers but goes through functional cortical specialization across development, probably due to a fine-tuning process triggered by environment. Moreover, an efficient processing of structural face features may represent a prerequisite of social categorization based on ethnicity, in line with a neuroconstructivist perspective.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_385752_xVt72X3ZJf.png
Caption 1: Cortical source reconstruction of vMMN modulation due to perceptual categorization in adults (left panel) and children (right panel)

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Increasing the perceived size of the own hand by changing its cortical somatosensory map with rTMS

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Incoming sensory information can influence the abstract representations of one's own body (i.e. Body Image). Indeed, evidence from healthy and neurological individuals suggests that the Body Image is flexible, and can be modulated by altered tactile inputs: a reduction of afferent inputs following peripheral nerve block or anaesthesia can increase the perceived size of the deafferented/anaesthetized body part; increased tactile stimulation also tends to affect the perceived body size (Gandevia et al. 1999).
Although this bottom-up relationship between somatosensation and Body Image is well established, the role of the primary somatosensory cortex (S1) in such a high-order body representation remains poorly understood. Here, we investigated this issue by using off-line repetitive Transcranial Magnetic Stimulation (rTMS) to assess whether altering the cortical representation of the left hand in right S1, by means of high (10 Hz) or low (1 Hz) frequency rTMS, affects the perceived size of the hand.
Twenty healthy participants completed a visual task, the Hand Size task, and a tactile task, the 2-point discrimination task (2PDT), before and after low- and high-frequency rTMS over S1, delivered in two separate sessions. In the Hand Size task, pictures of the participant's left and right hands were scaled to be 18%, 15%, 12%, 9%, 6%, or 3% bigger or smaller than his/her real hand; subjects had to judge whether the presented hand (which could be scaled or not) matched their own hand size or not. In the 2PDT, the participant's left hand was touched with one point or with two points (2-point distances: from 7 to 11 mm); the task required reporting whether one or two points was felt on the left hand.
In the 2PDT, 1 Hz rTMS to S1 efficiently reduced participants' tactile discrimination; accordingly, in the Hand Size task, after low-frequency rTMS subjects tended to over-estimate the size of their left and right hands (Fig.1). By contrast, 10 Hz rTMS did not modulate tactile perception (2PDT) or the perceived hand size (Hand Size Task, see Fig.2).
In line with previous studies showing the emergence of perceptual distortions of the Body Image by local anaesthesia, our results show that rTMS-induced changes of the central somatosensory maps lead to an overestimation of one's perceived hand size, which are likely linked to the contraction of the hand representation. Overall, this evidence highlights the importance of S1 in the construction and maintenance of the Body Image, supporting its role in high-order cognitive processes.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_385773_RNweZ0f9st.jpg
Caption 1: Fig.1. Hand Size task: performance before and after 1Hz rTMS.

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img2_385773_RNweZ0f9st.jpg
Caption 2: Fig.2. Hand Size task: performance before and after 10Hz rTMS.

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Tracking the effect of cathodal direct current stimulation on cortical excitability and connectivity by means of TMS-EEG

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Despite transcranial direct current stimulation (tDCS) is increasingly used in experimental and clinical settings, its precise mechanisms of action remain largely unknown. At a neuronal level, tDCS modulates the cortical excitability by shifting the resting membrane potential in a polarity-dependent way: anodal stimulation increases the spontaneous firing rate in the stimulated region, while cathodal decreases it. So far, the neurophysiological underpinnings of the immediate and delayed effects of tDCS are still unclear, as well as, it is not fully understood how the stimulation of a given cerebral region may affect the activity of anatomically connected regions. In a previous study it has been investigated the tDCS anodal's effect on the cortical excitability, by a combination of Transcranial Magnetic Stimulation (TMS) and Electroencephalography (EEG). Results showed a diffuse rise of cortical excitability in a bilateral fronto-parietal networks. In the present study, we used the same technique and methodological settings in order to explore local and global cortical excitability modulation during and after cathodal tDCS. Single pulse TMS was delivered over the left posterior parietal cortex (PPC), before, during, and after 10 minutes of tDCS over the right PPC, while EEG was recorded from 60 channels. For each session, indexes of global and local cerebral excitability were obtained, computed as global and local mean field power (Global Mean Field Power, GMFP and Local Mean Field Power, LMFP) on mean TMS-evoked potentials (TEPs) for four temporal windows: 0-50, 50-100, 100-150 and 150-200 milliseconds. The global index was computed on all 60 channels. The local indexes were computed in four clusters of electrodes: left and right, in frontal and parietal regions. The preliminary results on fifteen subjects show no differences in both sessions during and after cathodal tDCS compared to pre-stimulation session. These results are consistent with the literature in which the coupling of anodal-excitatory and cathodal-inhibitory effects are well established in the sensory and motor domains, both at physiological and behavioral levels, while the evidence is more controversial for higher-level mental activity.

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Neurophysiological correlates of creative cognition in the scientific and artistic knowledge domains

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Creativity is an essential aspect of arts, sciences, as well as everyday life. Creativity is usually defined as the ability to produce novel and useful products within a certain social context (Runco & Jaeger, 2012), or the potential for originality and effectiveness (Corazza, 2016). Interestingly, a number of results emerged from the scientific literature demonstrated the different influence of personality traits (e.g., Feist, 1998) and cognitive abilities (e.g., Batey & Furnham, 2006) in different knowledge domains. However, to the best of our knowledge, no study has explored whether brain dynamics underpinning creative thinking show domain-specific differences.
EEG studies addressing the neurobiological basis of creative cognition have linked creative thinking, in particular divergent thinking, to alpha band (8-12 Hz) brain oscillations. In the context of the present study, EEG alpha oscillation has been explored during the execution of a divergent thinking task in two groups of participants respectively representing the artistic (i.e., fashion students) and the scientific (i.e., bio-engineering students) knowledge domains.
Participants were asked to perform a modified version of the Alternative Uses Task (AUT; Guilford, 1967), in which they had to sequentially produce four alternative uses for objects of common use. Originality of the creative production (Acar & Runco, 2014) was used as a measure of participants creative abilities (Agnoli et al., 2016). As already emerged in the literature (e.g., Fink & Benedek, 2014), results confirmed that the generation of alternative ideas in the divergent thinking task was related to a variation of alpha power in the temporo-parietal regions. However, we were able to identify differences in the alpha oscillation between the two domains. Specifically, even if both groups were characterized by a brain asymmetry in the alpha band in the temporo-parietal region, a right synchronization characterized the artistic domain, while a left desynchronization characterized the scientific domain. Interestingly, overall statistics from artistic and scientific domains did not differ in terms of behavioral response (i.e., originality scores).
These results shed new light on the electrophysiological correlates that contribute to the creative production controlling for domain of expertise (Furnham, Batey, Booth, Patel, & Lozinskaya, 2011), testifying, arguably for the first time, different brain dynamics during idea generation between persons specializing in artistic versus scientific knowledge domains.

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The role of the dorsolateral prefrontal cortex in the motor placebo effect: a tDCS study.

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The placebo effect can be defined as a psychobiological response due to the application of a sham treatment together with verbal suggestion of positive benefit. Regarding motor performance, placebo effects have been described as improvement of speed, force and resistance to fatigue. Knowledge on the brain regions involved in the motor placebo effect is still scant. Some evidence hints at the involvement of the primary motor cortex, but whether other brain areas are involved is unknown. Studies in the field of pain converge in indicating the dorsolateral prefrontal cortex (DLPFC) as a crucial area for placebo analgesia. Being the DLPFC involved in higher-order cognitive functions, like expectation and anticipation, and connected with brain regions controlling motor behaviour, it is reasonable to hypothesise that it could play a role also in the motor placebo effect. To investigate this hypothesis, we applied transcranial direct current stimulation (tDCS) over the left DLPFC during a placebo procedure in the motor domain.
In a first experiment, nineteen healthy volunteers performed a motor task by pressing as strongly as possible a piston with the right index finger and received an analogue visual feedback on a PC monitor signalling the level of force. To induce a placebo effect, we applied transcutaneous electrical nerve stimulation (TENS) to the index finger along with verbal instruction about its effects in increasing force (although it was inert). Subjects were also conditioned about the effects of TENS by means of a surreptitious enhancement of the visual feedback. In a second experiment, thirty-two different healthy volunteers performed the same motor task, but without conditioning. In a third control experiment, fourteen additional healthy volunteers performed the same motor task with TENS, but without verbal suggestion and conditioning (they knew that TENS was inefficient). In all the experiments, each subject received anodal, cathodal and sham tDCS stimulation online during the procedure in different days.
We found stronger force levels at the end of the placebo procedure in the first and second experiments, suggesting that the paradigm was suitable to induce motor placebo effects. However, no difference was observed between the three types of tDCS stimulations suggesting that tDCS on the DLPFC does not modify the placebo effect. Interestingly, we found that verbal suggestion alone (second experiment) induced higher perception of force at the end of the experiment, selectively after sham tDCS and not after anodal or cathodal tDCS, suggesting that tDCS could have interfere with the subjective component of the placebo effect. No effect was found in the control experiment.
In summary, it appears that independently of the polarity, tDCS over the left DLPFC has not effect on the behavioural aspects of the motor placebo effect, whereas it seems to modify the subjective perception of force only in those participants who were verbally suggested.

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The sense of body ownership across the life span: new evidence from the rubber hand illusion

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One fundamental component of the bodily self is the sense of body ownership, which refers to feeling of “my body as mine”. The sense of body ownership has been extensively investigated by means of the rubber hand illusion (RHI). This paradigm allows to measure both cognitive and perceptual components involved in the sense of body ownership. In spite of copious literature on young population, little is known about this function in middle-aged and older-adults. Since the body changes across the life span, the question arises on whether concomitant age-related changes could be found also in the sense of body ownership. Here we address this issue by means of the RHI. Proprioceptive drift (i.e., recalibration of perceived position of the participant’s hand toward the rubber hand) and subjective reports (i.e., questionnaire) of the illusion were compared among young-adults (n=25, age range: 19-25 years), middle-aged (n=20, age range: 44-55 years) and older-adults (n=22, age range: 60-72 years). No differences have been found between groups in the proprioceptive drift. Conversely, with regards to the questionnaire, the middle-aged group showed lower scores at the statements specifically assessing the sense of body ownership compared to young- and older- adults. Interestingly, no differences have been found between the young- and the older-adults at the same statements. These findings demonstrate for the first time that the subjective component of the sense of body ownership changes across the life span following a U-shape. Two alternative interpretations could be advanced. More precisely, the results could be interpreted as the behavioral effect of 1) different stages in the development of perceptual and cognitive functions related to the subjective feeling of body ownership; 2) compensatory mechanisms related to age-related changes in brain structures and functions.

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XXV CONGRESSO DELLA SOCIETA ITALIANA
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Sessione Poster 2 - venerdì 17 novembre 2017 - 13.30 - 14.30

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Theta-burst stimulation exerts therapeutic effects in early experimental parkinsonism: a possible role of extracellular GluN2B subunit-containing NMDA receptors

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In experimental models of Parkinson's disease (PD), gradual degeneration of nigrostriatal dopaminergic neurons produces distinct alterations of dopamine-dependent corticostriatal synaptic plasticity over the course of the disease. We have recently shown that repetitive transcranial magnetic stimulation (rTMS) induces a rescue of corticostriatal plasticity with recovery of akinesia associated with selective increase of dopamine in dorsolateral striatum of late parkinsonian animals, together with a reduction of astrogliosis and microgliosis. Based on these data we hypothesize that rTMS may alleviate symptoms and improve the response to therapy in PD patients also through non-synaptic mechanisms. Using intracellular recordings from corticostriatal slices from low-dose 6-hydroxydopamine (6-OHDA)-lesioned rats, modelling early PD, we show that a single session of *in vivo* cortical rTMS, using intermittent theta-burst stimulation (iTBS) protocol, could recover motor functions and rescue corticostriatal long term potentiation in partially-lesioned rats. This effect was mediated by GluN2B subunit-containing NMDA receptors, as selective inhibitor ifenprodil was able to abolish TMS-mediated plasticity. Further support to our hypothesis is provided by molecular analysis showing a marked decrease in GluN2B in the postsynaptic compartment after TMS, pointing to a possible recruitment of extrasynaptic GluN2B in this form of TMS-mediated plasticity. Taken together, these data suggest that pathways classically associated with excitotoxicity may be instrumental to compensative responses with a therapeutic outcome.

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CEREBELLAR DIRECT CURRENT STIMULATION MODULATES HAND BLINK REFLEX

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The cerebellum is involved in a wide number of integrative functions. In the present study, we evaluated the role of cerebellum in peripersonal defensive behaviour, following cerebellar activity modulation with transcranial direct current stimulation (tDCS) and recorded the changes of the Hand Blink Reflex (HBR). We enrolled twenty right-handed healthy subjects (ten women; mean age ± SD: 25.2 ± 5.4 yr), with no history of neurological disorders, testing them with cerebellar tDCS (tcDCS: sham, anodal and cathodal) and motor cortex tDCS (anodal or cathodal; 20', 2 mA). We obtained the HBR with electrical stimulation of the median nerve at the wrist and recorded EMG activity from the orbicularis oculi muscle bilaterally. HBR was assessed in four different conditions, depending on the hand position relative to the face of the subject: "hand far", "hand near" (eyes open), "side hand" and "hand-patched" (eyes closed). tcDCS applied over the cerebellum in shame or cathodal conditions, did not affect HBR. Anodal tcDCS greatly reduced the amplitude of the HBR, measured by the area under the curve (AUC), in the "hand-patched" and "side hand" conditions only, for ipsilateral ($F_{(4,171)}$ = 15.08, $p < 0.0001$; $F_{(4,171)}$ = 8.95, $p < 0.0001$) as well as contralateral recordings ($F_{(4,171)}$ = 17.96, $p < 0.0001$); $F_{4,171)}$ = 5.35, $p = 0.0004$); while the anodal tcDCS not modify AUC in the "hand far" and "hand near" sessions. tDCS applied over the primary motor area, had no significant effect on HBR results. Our results define the role of the cerebellum in defensive responses within the peripersonal space around the face, suggesting a possible cerebellar involvement in visual-independent defensive behaviour.

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Cortical mechanisms of natural scene segmentation: coding of object regions and borders in humans.

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Making sense of the surrounding world mostly depends on cortical mechanisms of scene segmentation, i.e. the ability of our visual system to extract low-level features and cluster them as perceptual objects.
In primates, two cortical mechanisms have been targeted as neural correlates of segmentation processing: region-filling and border-ownership (BO). The former involves the spreading of enhancement and suppression feedbacks throughout the whole visual cortex: signaling of neurons whose receptive field (RF) covers the figure are enhanced while neurons whose RF lie on ground are suppressed. The latter, instead, consists in cell selectivity for borders in a low-level invariant fashion, and is thought to be resolved by vertical feedbacks: a BO cell start signaling when a contrast-defined edge is represented within its RF, then, its activity is sustained by an higher “grouping cell” if the activity of multiple afferent BO cells matches its prior representation (e.g., co-circularity and gestalt cues as convexity). The two mechanisms rely on different timing: region-filling mechanisms are distributed (including V1, V2 and V4) and slow (enhancement appears within 95-100ms followed by later suppression), while BO is local (V2) and fast (within 70ms).
In humans, in a previous fMRI study, we found evidence of region-filling mechanisms in humans passively attending 334 natural images (Papale et al., *biorXiv*, 2017). Specifically, we observed foreground-enhancement in seven region of interest (ROI) - V1, V2, V3, V3A, V3B, V4 and the lateral occipital complex (LOC) – and background suppression in V3B, V4 and LOC. Here, we present results from a second analysis on the same ROIs. Employing population receptive field (pRF) estimation, we investigated border coding in humans by testing voxel selectivity for borders within their RF. In brief, for each voxel we run pRF on a separate dataset (brain responses to 1437 training + 99 testing images) and computed its significance with a permutation test. Then, we compared the response of a voxel when it RF contains a border and when it is entirely within an object: a voxel selective for object-borders should respond higher in the former case. No significant differences were found.
Taken together, our results appear to suggest that region-filling, but not BO mechanisms, can be observed in humans. As BO can be decoded in population of cells in V2 and V3 in primates, it was theoretically possible to detect BO in humans with fMRI, similarly to fine-grained coding schemes of visual populations (e.g., center-surround suppression) observed before. However, as the BOLD signal is sensitive to synaptic activity, but not specifically tuned to the spiking rate of neurons, we cannot exclude that evidence for BO mechanism could be observed only using less biased techniques, as ECoG. In conclusion further research is needed to fully describe cortical mechanisms related to segmentation and perceptual grouping in ecological conditions.

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LTP-like cortical plasticity in AD patients: a novel biomarker of disease progression.

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AD diagnosis is performed according to criteria based on clinical presentation and presence of beta-amyloid or tau pathology, detected either by cerebrospinal fluid (CSF) examination or functional imaging, but there is still lack of sufficient accuracy in evaluating disease severity and predicting disease progression. Thus, efforts are underway to combine multiple biomarkers to predict the severity of AD. Synaptic dysfunction represents a key driver of AD-related cognitive decline. Cortical plasticity mechanisms, especially Long Term Potentiation (LTP) can be assessed in humans by means of transcranial magnetic stimulation. Our aim is to establish the predictive value of LTP-like cortical plasticity as a prognostic biomarker of disease progression in terms of cognitive decline.
We applied different neurophysiological protocols in a sample of 60 AD patients and 30 age matched healthy controls (HC). ROC curve analyses were performed to evaluate the sensitivity and specificity of LTP biomarker and short-afferent inhibition (SAI), marker of central cholinergic activity, in discriminating AD patients from age-matched healthy controls.
We found that area under curve (AUC) was 0.90 for LTP, indicating an excellent diagnostic accuracy of this biomarker, but only 0.64 for SAI. We performed univariate regression analyses for LTP, SAI, CSF biomarkers, APOE4 genotype, neuropsychological evaluation as well as disease duration, education and demographic factors. The results showed that LTP was the only significant predictor of disease progression ($p=0.02$), while there was no effect for SAI ($p=0.84$), CSF total tau ($p=0.10$), CSF p-tau ($p=0.21$), CSF Aβ ($p=0.54$), APOE4 genotype ($p=0.32$), neuropsychological battery and other demographic factors. The probability of disease progression significantly decreased with every point increase of LTP ($p=0.04$). ROC curve was also performed to evaluate the sensitivity and specificity of LTP biomarker in predicting cognitive decline in AD patients. We found an AUC=0.71 indicating a fair prognostic accuracy of this biomarker in discriminating among AD patients those with faster disease progression. ROC analysis replicated in a subsample of patients in which APOE genotype was available (n=46), separately in APOE4 and APOE3 patients, we found that AUC was higher for APOE4 (0.85) than APOE3 (0.70).
LTP impairment discriminates excellently AD patients from HC; moreover only LTP shows good predicting value on clinical progression.
LTP impairment can be considered as a biomarker of progression in AD patients.

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Electrophysiological correlates of proactive and reactive cognitive control

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Abstract
According to the dual mechanisms of control (DMC) theory (Braver et al., 2012), cognitive control encompasses a proactive and a reactive mode. The proactive mode is engaged in actively maintaining goal-relevant information in a sustained manner, in anticipation of cognitive demanding events, in order to optimally bias attention, perceptual, and action systems in a goal-driven manner. The reactive mode is a “late correction” transient mechanism, which is mobilized when a high-interfering event is detected to resolve the conflict. There is still little evidence that accounts for distinct neural bases supporting these mechanisms. In order to elucidate the differential involvement of these processes in cognitive control, an ERP study was conducted. A group of 23 participants (mean age: 41.2 years, range: 22-60) took part in the study. They performed a cued Continuous Performance Task (AX-CPT). The electrophysiological activities in response to cue and to probe were examined. In contrast to previous literature, the percentage of stimuli was adjusted to equate the frequency of trials where participants could anticipate the probe (A trials) and the frequency of trials where they could not (B trials). This manipulation helped to remove possible confounds associated with first-order frequency effects, leaving the conditional probability of target responses unaffected. The ERP results showed clear anticipatory attentional marker (i.e., a fronto-central contingent negative variation, CNV) preceding the probe in the A trials only. On the other hand, they revealed that inhibitory components (frontal N2) were elicited by the probe, but only when it was not expected. Overall, the findings showed distinct ERP markers of proactive and reactive control mechanisms. Importantly, they revealed that the task-relevance features of the cue, rather than the frequency of the cue-probe association itself, affects anticipatory control processes.

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Age-specific spectral correlates of interference resistance processes

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Testo Abstract (2968 caratteri spazi inclusi):
The ability to boost the processing of task-relevant information while suppressing that of dominantly represented but irrelevant one (i.e., interference resistance) is an essential component of executive functioning that is commonly investigated using the Stroop paradigm. Converging evidence suggests that this cognitive control process is mediated by the left prefrontal cortex. However, the specific mechanisms used by our brain to deal with interference in this type of task are still debated. The first aim of the present study was to investigate the temporal dynamics of interference elicited in the Stroop task by analysing spectral parameters of EEG activity during the execution of a spatial version of the Stroop task. A second aim was to investigate if cognitive control involved in these tasks and the corresponding electrophysiological correlates change during the lifespan. Indeed, cognitive deficits in healthy older adults are usually largest for tasks requiring cognitive control processes, and many theories of cognitive aging assume a progressive decline in prefrontal functioning. To these aims, the spatial Stroop task was administered to younger and older participants while recording EEG activity. Behavioural data analysis revealed the classical Stroop effect, that is, higher response times (RTs) and lower accuracy for incongruent trials as compared to congruent ones. Moreover, older participants showed a general RT slowing. An event-related spectral perturbation (ERSP) analysis was conducted to identify spectral dynamics specifically linked to interference resistance processes and potential group differences in these electrophysiological correlates of Stroop performance. ERSP results revealed a number of significant modulation related to interference resistance processes. In particular, we found a major involvement of beta frequencies, with a stronger power suppression during incongruent trials. Importantly, this effect was modulated by age. Indeed, in the younger group this effect was evident over left-lateralized prefrontal regions of the scalp before the response, whereas in the older group it was spread over the scalp and occurred around the time of the response. These results were extended by computing correlations between behavioural and electrophysiological measures to investigate if changes in the Stroop performance could be linked to specific oscillatory markers. A number of significant correlations were found, involving different frequency bands, again with age-specific spatio-temporal characteristics. In light of these results, and in order to obtain more direct evidence of the left prefrontal involvement in interference resistance processes, a distributed source analysis was performed. Preliminary evidence confirms that middle and superior frontal gyri and supplementary motor area in the left hemisphere play a key role in Stroop performance.

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The effect of negative words on motor performance: evidence from placebo and nocebo procedures.

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Placebo and Nocebo refer respectively to a positive or a negative outcome induced by expectation about the effect of a treatment, actually inert. These effects can be induced by conditioning processes and verbal suggestion, that typically match (i.e., both positive or both negative). Until now, no study has examined what happens when these two variables do not go hand by hand. Our study included 50 participants tested in a motor task and assigned to four groups: two with congruent conditioning and verbal suggestion (both positive or negative) and two with incongruent ones (one positive and one negative). The protocol consisted of three sessions and after the second and third sessions an inert treatment was applied with verbal suggestion of improvement or worsening. During the conditioning procedure a visual feedback (surreptitiously manipulated) indicated the force level: in two groups the feedback manipulation was congruent with the verbal suggestion; while in other two groups it was incongruent. Results showed a strong decrease of force in the groups with negative verbal suggestion, independently of the conditioning. These groups also showed a lower perception of force and a higher sense of effort at the end of the procedure compared to the beginning. During the procedure, TMS was applied over the primary motor cortex to investigate the excitability of the corticospinal system. Results showed a general shortening of the cortical silent period in all the groups. These findings hint at a more prominent role of verbal suggestion compared to conditioning, especially during a nocebo procedure.

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fMRI response to active leg movements in human egomotion-related areas

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When we move in a complex and dynamic environment, optic flow constitutes a rich source of essential visual cues for guiding egomotion among stationary or moving objects and facilitating navigation through the external environment (Marigold, 2008; Bremmer, 2011). Egomotion perception involves the integration of multiple sensory signals arising from visual as well as from vestibular, somatosensory and motor systems (Greenlee et al., 2016). Monkey neurophysiology and human neuroimaging studies have demonstrated that passive viewing of optic flow stimuli activates a large cortical network of temporal, parietal, insular and cingulate motion regions (including the well-known areas MST, VIP, PIC, V6 and CSv). Although all these regions respond to egomotion compatible visual stimuli, there are many differences among them in terms of anatomical position, retinotopic organization and functional properties. Recently it has been shown that area CSv has stronger cortical connections to medial somatosensory and motor areas than to posterior visual regions (Smith et al., 2017). One possible hypothesis is that while posterior regions (as V6) contribute to the visual analysis of egomotion signals, anterior regions close to the somatosensory and motor areas (as CSv) provide sensory information to the motor system with the aim of guiding locomotion.
To test this hypothesis, we used a combined approach of brain mapping methods, task-evoked activity and resting-state functional connectivity by fMRI. We localized with high consistency across 18 subjects a set of six egomotion-related areas (V6, V3A, VIP, CSv, pC, PIC) by using a Flowfields stimulus (Pitzalis et al., 2010). Then, we tested their response to a motor task implying active movements of upper (arm) and lower (leg) limbs. Results reveal that CSv, pC and PIC respond to leg movements in contrast to V6, V3A and VIP, which are not activated during the motor task. In addition, functional connectivity analysis shows that CSv, pC and PIC are massively connected with specific components of the motor system, in particular the cingulate motor areas and the supplementary motor area (SMA). Notably, CSv and PIC are also connected with the medial portion of the somatosensory cortex, which represents the legs and feet. We found a gradient of functional specialization and cortical connections, with the most posterior regions primarily dedicated to the analysis of visual attributes useful for spatial navigation and the most anterior regions responding to active leg movements and that are concerned less with perceiving self-motion than with guiding action, particularly during locomotion.
In conclusion, both task-evoked activity and functional connectivity raise the possibility that CSv, pC and PIC receive locomotion-relevant proprioceptive information as well as visual and vestibular signals. We propose that CSv, pC and PIC provide a pivotal link between perception and action that serves the online control of locomotion.

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Dipolar source modeling of contact heat evoked potentials (CHEPs) to both hand and foot stimulation

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CHEPs recording has proved to assess the peripheral A∂ fibers and the central spino-thalamic tract specifically. Indeed, the scalp responses recorded to contact heat stimulation of the hand are generated by the same dipole sources calculated from the topographic distribution of the laser evoked potentials (LEPs), considered as the gold standard for the investigation of the nociceptive pathway (Valeriani et al., 2002). To the best of our knowledge, the CHEP sources to foot stimulation have never been studied. The aim of the present study was to calculate the dipole source models explaining the scalp distribution of CHEPs to both hand and foot stimulation. Nine healthy subjects (5 females, 4 males; mean age 25.22 ± 3.15) were recruited. CHEPs were recorded form 31 scalp electrodes to stimulation of the right hand dorsum and right foot dorsum. The target heat temperature was 51 ºC. The interstimulus interval was 15 sec. An average of 50 trials was calculated for each stimulation site. EEG epochs were baseline corrected using the prestimulus interval. Trials contaminated by eye blinks and movements were rejected. The brain electrode source analysis (BESA) was used to calculate the dipole models, considering the EEG intervals showing the biological responses. First, the grand averages of CHEPs calculated from all our subjects to hand and foot stimulation were analysed. Then, the obtained models were tested on the individual traces. A five-dipole model could explain the CHEP scalp topography, independently of the stimulation site. It included a bilateral source on the opercular region, possibly corresponding to the SII area, a midline source, approximately located in the anterior cingulate cortex, and a bilateral deep source in the insular region. The grand average models showed a good residual variance (5% and 7% for hand and foot stimulation, respectively) and could be applied also to the individual traces. When we tried to add a further source, located in the cerebral region of the SI area, it did not activate and the model residual variance did not improve. Our results show that the sources subtending scalp CHEPs to both hand and foot stimulation are the same as those explaining the LEP topography (Valeriani et al. 2000). Moreover, as for LEPs, SI dipole does not need to be included in the CHEP dipole source model.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381699_FS5xV83OkB.jpg
Caption 1: Grand average model of CHEPs to hand stimulation. The last source represents a putative SI dipole which does not activate.

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381699_FS5xV83OkB.jpg
Caption 2: Grand average model of CHEPs to foot stimulation. The last source represents a putative SI dipole which does not activate.

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Event Related Potentials recorded by intracerebral electrodes

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Preoperative evaluation, by means of intracerebral electrodes, in patients presenting with symptomatic drug resistant epilepsy, provides an opportunity to explore neural generators of P300, Mismatch Negativity and also N140. We studied 5 pediatric patients with drug resistant epilepsy. ERPs and SEPs (to median and tibial nerve stimulation) were recorded from the intracerebral electrode contacts referred to the earlobe ipsilateral to the stimulation. P300 was recorded by electrodes located in hippocampus with a clear inversion of signals in posterior hippocampus; MMN was also well recorded by electrodes placed in opercular-insular cortex without a clear inversion of signal; N140, increased in amplitude during attention condition, showed the maximum amplitude in the frontal electrode contacts and in the opercular-insular traces. Numerous investigations revealed that generators of Event Related Potentials are independent and also with a cortical-subcortical distribution. In this short case series, we could show some brain areas clearly involved in the generation of P300, MMN and N140 components.

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Spinal inhibition of the nociceptive input by higher frequency non-painful stimuli

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Objectives. The neurophysiological mechanism subserving the analgesia induced by rubbing the painful part of the body or during TENS is still unknown. Our aim was to investigate the site of this inhibition
Materials and Methods. We studied 10 healthy volunteers. LEPs were recorded after stimulation of the radial and ulnar territories of both the right and left hand dorsum in 2 conditions: 1) no conditioning stimulation (baseline condition), and 2) high-frequency (5 Hz) non-painful electrical stimulation of the right radial nerve (gating condition).
Results. As compared to the baseline, in the gating condition the N2/P2 amplitude was reduced in amplitude after stimulation of the radial territory of both hands ($p<0.001$ and $p<0.001$ for right and left hand, respectively) and of the right ulnar region ($p=0.008$), while no inhibition was found to left ulnar region stimulation ($p=0.06$).
Discussion. High-frequency non-painful stimulation of the right radial nerve inhibits the nociceptive input coming from both the ipsilateral and contralateral homotopic regions, and from a close ipsilateral heterotopic territory. On the contrary, it does not have any effect on the nociceptive input due to stimulation of a contralateral heterotopic area.
Conclusions. Our results suggest that spinal segmental inhibitory mechanisms are mainly involved.

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Whole-brain resting state default mode network connectivity during spontaneous migraine attacks

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Background – The default mode network (DMN) is composed by a set of regions including medial prefrontal cortex (MPFC), posterior cingulate cortex (PCC), and parietal lobule (PL). A disruption of DMN connectivity was observed in migraine between attacks.
Aim – Here we investigated resting state DMN connectivity during spontaneous migraine attacks.
Method – Thirteen patients with untreated migraine without aura (MI) underwent 3T MRI scans during the initial 6 hours of a spontaneous full-blown migraine attack and were compared to a group of 19 healthy volunteers (HV). We collected resting state data in the default mode network identified by a seed driven approach. In a second-level analysis, we collected whole-brain connectivity patterns with the seeds representing DMN (conjunction analysis).
Results – There was greater correlation in MI than in HV between regions typically associated with DMN, including MPFC, PCC, and PL. The conjunction analysis revealed common activation between i) MPFC and left inferior frontal cortex (pars triangularis), left dorsal posterior cingulate cortex, and left associative visual cortex; ii) right PL and bilateral somatosensory association cortices, and left associative visual cortex.
Conclusion – In sum, we documented associations between DMN and brain regions involved in multimodal brain processing, including visual, somatosensory, and verbal during spontaneous migraine attacks. Whether present findings are related to the ictal migraineurs abnormal sensory perception, such as photophobia and allodynia, and to the ictal drop in verbal fluency remains to be determined.

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Frequency tagging insular activity related to tonic heat pain: evidence from intracerebral recordings

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The insula is an important target for spinothalamic thermonociceptive input, and phase-locked local field potentials (LFPs) elicited in the human insula by transient nociceptive stimuli have been described extensively (Frot et al., *Hum Brain Mapp* 2014). However, these LFPs primarily reflect multimodal activity unspecific for pain (Liberati et al., *Plos Biol* 2016). The present study aimed at identifying, in humans, insular activity related to sustained nociceptive input using electroencephalography (EEG) frequency tagging, through the periodic activation of thermonociceptors (Colon et al., *Neuroimage* 2016).
We recorded intracerebral EEG (iEEG) in 6 patients undergoing a presurgical evaluation of intractable epilepsy, for a total of 47 insular contacts (32 in the left insula and 15 in the right insula). Long-lasting (75 s) thermonociceptive (50°C) and non-nociceptive vibrotactile stimuli were delivered to the hand contralateral to the implanted insular electrode. Stimulation intensity was modulated at 0-2 Hz, to “frequency tag” sustained insular activity generated by these long-lasting stimuli (Figure 1).
Both sustained periodic thermonociceptive stimulation and sustained periodic vibrotactile stimulation elicited a marked increase of EEG power at the frequency corresponding to the frequency of stimulation (0.2 Hz), and its harmonics. A Hilbert transform analysis revealed that thermonociceptive stimuli elicited a clear peak at 0.2 in the theta, alpha, beta, and gamma frequency bands. In contrast, vibrotactile stimuli elicited a clear 0.2 Hz peak only in the beta frequency band (Figure 2).
A linear mixed model (LMM) analysis of the signal amplitudes at 0.2 Hz showed a significant interaction between “modality” and “frequency band” ($F=13.97$, $p<.001$). Post-hoc pairwise comparisons showed that in the theta and alpha frequency bands, the signal amplitude was significantly greater for the thermonociceptive modality compared to the vibrotactile modality ($p<.001$ and $p=.011$, respectively).
These findings suggest that the slow periodic activation of themonociceptors can be used to reliably identify – at single-subject level – insular activity related to the sustained activation of thermonociceptors, and that some features of this activity may differentiate it from the activity elicited by sustained vibrotactile stimulation.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381846_6ilRqbFZOe.jpg
Caption 1: A. Time-frequency analysis. B. Hilbert analysis

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381846_6ilRqbFZOe.jpg
Caption 2: A. Localization of insular electrodes. B. Thermonociceptive and vibrotactile stimulation applied to the hand

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Somatosensory Evoked Potentials During Mechanotactile Tapping on the Third Digit Somatosensory Evoked Potentials During Mechanotactile Tapping on the Third Digit Somatosensory Evoked Ootentials during Mechanotactile Stimulation Tapping on the Third Digit

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Usually, Somatosensory Evoked Potentials (SEPs) are performed by electrically stimulating peripheral nerves and recording the electrical activity on the scalp.
Electrical stimulation of the peripheral nerves ensures synchronous activation of all the nervous fibers regardless of the type, because it activates directly the fibers bypassing the transducers of the skin, thus is an efficient tool to test pathway integrity. However, for the same reasons, it is extremely not-physiological, thus not suited for investigating perception and reproducing normal afferences during real life interaction.
The number of studies employing more “natural” methods of somatosensory stimulation is small if compared to the overwhelming amount of papers that report SEPs elicited by electrical stimulation of the nerve. Moreover, they rarely report short latency cortical potentials, named as N20. This could be due to a combination of factors: the use of stimulation devices with different kinematics and the involvement of multiple cutaneous transducers with different times of activation and conduction velocities of the stimulated fibers.
In the present work, we report preliminary findings obtained through high density electroencefalographic (EEG) recordings evoked by tapping the dorsal surface of the distal phalanx of the right hand third digit with a custom mechanotactile stimulator. The rotation of a servo motor applied on a lever shaft produces the tapping of the end effector of the device with a frequency of 1.67 Hz on the skin of the participants. A tactile sensor placed on such end effector allows to measure the dynamics of the interaction during the tapping.
62 active channel EEG cap was used along with the EEG amplifier allowing continuous data recording during the tactile stimulation. The reference was placed on the earlobe ipsilateral to the stimulation. Evoked potential were also recorded at the median nerve at wrist, at the Erb’s point and at the spinal C6 level. For each subject, a high number of trials (6500) were collected.
On the basis of the information recorded by the tactile sensor and on the afferent pathway, the latency of the cortical peaks were identified and mapped.
We found a positive wave about 45 ms after the stimulation on the centro-parietal electrodes contralateral to the stimulation, whereas the first negative peak was observed around 30ms in the centro-parietal electrodes. At the Erb’s point we observed a response after about 20 ms from the chosen trigger.
Since after the electrical stimulation of the median nerve at wrist, the latency from the spinal cord to the cortex is estimated to be about 11 ms, thus the negative peak we observed at 30ms is likely to correspond to the N20, the first cortical component typically recorded on the scalp after electrical stimulation of the median nerve at the wrist, while the positive peak observed at 45ms to the P35 component.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_387342_vSx9coEsi8.jpg
Caption 1: Schema of the movement of the mechanotactile stimulator

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SSVEP responses from the blind field of hemianopic patients. A role of prefrontal cortex in conscious perception?

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The present study is concerned with a comparison between the electrophysiological responses obtained from visual stimuli presented to the blind or sighted field of hemianopic patients. The general aim is to try and find a neural correlate of visual perceptual awareness. To achieve this goal, a Steady-state visual evoked potentials (SSVEPs) stimulation was conducted in a group of three patients with damage to the left visual cortex and consequent right homonymous hemianopia, and thirteen young healthy participants. Stimuli consisted of four black-and-white sinusoidal Gabor gratings presented one in each visual field quadrant and flickering one at a time with contrast reversal at a 12 Hz rate. In patients the stimulus was positioned in the blind area on the basis of the results of the clinical campimetry and of a visual mapping test carried out in the lab. Data analysis concerned, first, a reliability assessment of the SSVEP signal by means of a Signal-to-Noise Ratio computation. Further analyses were performed in the frequency domain for posterior and prefrontal electrodes by comparing groups (patients and healthy participants), hemispheres (left/damaged and right/intact) and visual fields (left/sighted and right/blind).
Notably, SSVEP stimulation yielded reliable responses from the blind hemifield in addition to those from the intact fields. Frequency analysis on parieto-occipital electrodes of healthy participants showed a significant difference between contralateral and ipsilateral hemispheres with respect to side of stimulation. A similar pattern was observed for the sighted field of patients. In contrast, no such difference was found in the blind hemifield, but a contralateral temporo-parietal activity was observed in the topographic maps. This kind of response supports the idea that it is mainly generated by extrastriate cortical areas bypassing V1.
Analysis of prefrontal activity was carried out by comparing left and right visual fields; in healthy participants no difference was found while in patients a significant difference was observed between blind and sighted visual fields with a greater bilateral prefrontal magnitude of power at the same frequency of the SSVEP only in the intact hemifield suggesting its important role as a correlate of perceptual awareness. Previous work on healthy participants found that its origin is in the anterior insula.
In sum, the main thrust of the present study is twofold: first, we found that stimuli presented to the blind hemifield yield a highly reliable electrophysiological response; second, a prefrontal component is present when stimuli are visible (as in healthy participants and in the intact hemifield of hemianopics) but is absent when stimuli are not perceived (as in the blind hemifield).

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Somatotopic analgesic effect of abdominal acupuncture

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Objective. Abdominal acupuncture (AA) reduces laser-evoked potentials (LEP) amplitude and laser pain perception in healthy subjects (Pazzaglia et al., 2014). The aim of the current study was to investigate the site of AA analgesic effect. Material. We recorded LEPs in 15 healthy volunteers by using the 32 EEG scalp electrodes. All subjects underwent a AA protocol, the needles were fixed in the areas of the “turtle representation” of the body, corresponding to bilateral dorsal wrist and right foot. Methods. The experimental protocol included 3 times: 1) baseline, in which LEPs to stimulation of the bilateral dorsal wrist and right foot were recorded before acupuncture; 2) acupuncture, in which LEPs were recorded during AA performed in the abdominal area corresponding to right wrist; 3) rest, in which LEPs were recorded 15 minutes after the needle removal. Results. The N2/P2 LEP amplitude to stimulation of both wrist was reduced in the acupuncture and rest times as compared to baseline, while LEP amplitude to foot stimulation was not modified. Discussion.Abdominal acupuncture is able to reduce LEP amplitude. Since the homotopic regions of both sides are possibly connected within the spinal cord, our results suggest that the AA analgesic effect occurs at spinal level. On the other hand, the absence of any modulation of LEPs to foot stimulation is against the possibility of an AA general inhibitory effect. Conclusions. The analgesic effect of AA seem to be due to an effect on spinal level.
Pazzaglia C, Liguori S, Minciotti I, Testani E, Tozzi AE, Liguori A, Petti F, Padua L, Valeriani M. Abdominal acupuncture reduces laser-evoked potentials in healthy subjects. Clin Neurophysiol. 2015 Sep;126(9):1761-8. doi: 10.1016/j.clinph.2014.11.015.

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Serotonergic Central Tone in Parkinson's disease with Fatigue - contribution from Intensity Dependence of Auditory Evoked Potentials (IDAP)

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Fatigue has been reported to be a common and disabling symptom in Parkinson's disease (PD), affecting up to 58% of PD patients and worsening the patients' quality of life. Although little is known about the pathophysiological mechanisms underlying central fatigue, it has been suggested that it is related to a dysfunction of the basal ganglia, especially in non-dopaminergic pathways. Reduced serotonin transmission could have a role in the occurrence of fatigue in patients with PD.
The aim of the present study is to evaluate serotonergic central neurotransmission in PD patients with and without fatigue, by means of the intensity dependence of the auditory evoked N1/P2-response, which has proven to be a reliable neurophysiological index of the central serotonergic function.
30 non-depressed, non-demented PD patients (22 without fatigue - PDnF, 8 with fatigue - PDF measured by the fatigue severity scale – cut-off for the presence of fatigue >4) and 26 age and sex-matched controls underwent a neurophysiological evaluation. Auditory evoked potentials were evoked by four runs of 250 stimuli each with a randomized inter stimulus interval ranging from 500 to 900 ms. Tones of 1000 Hz and 50 ms duration (rise-fall times: 10 ms) were delivered binaurally through earphones at four different intensities (60, 70, 80 and 90 dB HL) in a pseudo-randomized order. Subjects were asked to fix a target in front of them in order to limit ocular artefacts; they were not informed about the sequence of different tones and were instructed to ignore themselves. N1 (between 50 and 150 ms stimulus) and P2 (between 120 and 200 ms post-stimulus) amplitudes were measured and the N1/P2 ASF slope was calculated as the linear amplitude/stimulus intensity function slope for block averages (μV/dB).
IDAP was significantly higher (meaning a lower serotonergic tone) in parkinsonian patients than controls (p=0,020). Analyzing patients separately accordingly to the presence of fatigue, IDAP was comparable between the two group of patients (ANOVA after bonferroni correction PDF vs PDnF p=1,00) while a difference still emerged between patients and controls, even when a post-hoc ANCOVA was conducted, with clinical characteristics incorporated as a covariates to directly check for any significant contribution made by these factors to the group difference.
Our results point to a reduction of serotonergic tone in Parkinson's disease, even in absence of depression and in early stages of the disease. Central fatigue in PD seems not to be related to the reduced serotonergic neurotransmission, especially in non-depressed patients. More studies are needed in order to verify the role of other neurotransmitters in the pathogenesis of central fatigue, particularly dopamine.

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GAMMA band oscillations evaluation after painful stimuli correlated to pain catastrophizing in fibromyalgia patients and healthy controls

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Many chronic pain conditions are associated with hypersensitivity of the nervous system to pain and impaired endogenous pain modulation. The fibromyalgic brain is characterized by a reduced habituation of evoked responses to laser stimuli suggesting alterations in the pattern of cortical excitability. Laser evoked potentials (LEPs) are a useful tool to study the nociceptive pathway. The vertex N2-P2 complex expresses the cortical response to the salient painful stimuli. Several study have demonstrated that brief painful stimuli induce gamma oscillations (30 – 120 Hz) in somatosensory cortex, which likely reflect the local processing of sensory information and subjective pain perception, regardless of the saliency content of the stimulus. Pain catastrophizing is a negative amplification of pain-related thoughts through rumination, magnification, and helplessness. Fibromyalgia patients (FM) have greater trait catastrophizing than controls. In this study we aimed to evaluate GBOs after stimuli in fibromyalgia patients and healthy subjects and to correlate GBOs and other LEPs features to pain catastrophizing, pain perception and clinical aspects. We recorded LEPs in 30 FM patients and 15 healthy controls by stimulating the right hand back. Subjective pain was rated on a visual pain analogue scale (VAS). All subjects were submitted to the Pain Catastrophizing Scale - italian version (PCS-I). The FM patients showed reduced LEPs habituation and increased laser-related GBOs. Both patterns were correlated with the PCS-I. In FM patients GBOs showed a positive relationship with pain catastrophizing, but not with laser pain, which showed a positive correlation with disease severity. The N2P2 habituation was confirmed as a discriminant factor between patients and controls. These findings confirm that reduced habituation to laser pain is a stable feature of central sensitization syndromes, while Gamma band representation may be a correlate of pain amplification at central level. LEPs habituation and GBOs may be the expression of cortical mechanisms of nociceptive stimuli processing and exaggerated attentional orientation toward pain experiences.

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Defective magno-, parvo-, and konio-cellular visual pathways in developmental dyslexia: evidence for a possible delayed myelination and cues for an integrated (re)habilitation programme.

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Aim of the present study was, as well as obtaining confirmation of the magnocellular system involvement in Developmental dyslexia (DD), to search for a possible involvement of the parvocellular system and, furthermore, to complete the assessment of the visual chromatic axis by also analysing the koniocellular system. Visual evoked potentials (VEPs) in response to achromatic stimuli with low luminance contrast and low spatial frequency, and isoluminant red/green and blue/yellow stimuli with high spatial frequency were recorded in 10 dyslexic children and 10 age- and sex-matched, healthy subjects. Dyslexic children showed delayed VEPs to both achromatic stimuli (magnocellular-dorsal stream) and isoluminant red/green and blue/yellow stimuli (parvocellular-ventral and koniocellular streams). The amplitude of the evoked responses, on the contrary, was not significantly reduced compared to normal readers. To our knowledge, this is the first time that a dysfunction of colour vision has been brought to light in an objective way (i.e., by means of electrophysiological methods) in children with DD. This dissociation suggests a general slowing of visual processing as a key feature of DD, consistent with a delayed myelination (i.e., dysmaturation) rather than with a reduced number of axons/neurons. This agrees with previous diffusion tensor imaging studies that detected signs of disrupted myelination in the left superior longitudinal (arcuate) fasciculus. The results obtained in the present study suggest that dysmyelination might be a widespread phenomenon in dyslexic brains, extending even outside the limits of the language network. These results give rise to speculation concerning the need for a putative approach for promoting both learning how to read and/or improving existing reading skills of children with or at risk of DD.

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Cortical median nerve somatosensory evoked potentials (cSEP)and cortical evoked high frequency oscillations(cHFO) in patients affected by movement disorders.

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Background and Rationale. The investigation of cHFO has achieved increasing interest in human functional and pathophysiological studies of several neurological disorders. The pathophysiological relevance of cHFO in movement disorders and cortical-subcortical excitability to be clarified. Purpose: to investigate the relationships between cSEP and cHFO in unilateral and bilateral movement disorders.
Materials and Methods. cHFO have been measured off-line (digital band pass filter 500-1000 Hz) from cSEP recorded over Cc' of the contralateral stimulated side in seven patients affected by movement disorders; were considered total number, amplitudes and frequency. Data control group, matched for age (**range 18-35**) were: mean number =9; mean frequency 700 Hz; mean amplitude 0,15 uV (total 1,35 uV).
Results. Four patients with unilateral movement disorders: cSEP were symmetrical (latency 17 ms, amplitude 7,5 uV); cHFO affected side: number=2; total amplitude:0,3 uV (unaffected side normal).Three case reports: a 10 yrs old with unilateral increased of cHFO (cSEP symmetrical); a 17 yrs old boy affected by cortical myoclonus, with enhanced cSEP and extinguished cHFO; a 60 yrs old men with ataxia and spastic paresis with unilateral extinguished cHFO and normal, symmetrical cSEP.
Conclusions.cHFO and cSEP pathological increase or decrease occurred independently each other: cSEP increased amplitude with cHFO increase and cHFO increased amplitude with normal cSEP. cHFO showed correlation with the type and side of movement disorder. Significance: a-the neuronal mechanism underlying cHFO and cSEP excitability occurred independently; b- cHFO are likely related with the neuronal inhibitory-facilitatory mechanisms involved in movement control.

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Eliciting the LAN and the N400 with picture-phrase incongruences: The effects of number morphology

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Morphological Number usually encodes the referential numerosity, denoting one entity (singular, SG) or more than one (plural, PL). However, also quantifiers encode information about the numerosity. We aimed to disentangle whether the information of numerosity encoded in the Number morpheme is accessed even when the noun is embedded in a phrase with a quantifier. We contrasted the Italian quantification expressions *un/a* 'a, an'+*nounSG*, *alcuni* 'some'+*nounPL*, *qualche* 'some'+*nounsSG*. Notably, both *qualche* and *alcuni* refer to a plural numerosity, but nouns agree in the plural with *alcuni* and in the singular with *qualche*.
We designed a picture–phrase matching paradigm. Each of the 30 countable nouns referring to concrete objects was paired with two pictures: the object was represented either once or four times. Each picture was displayed once with *un+nounSG*, once with *qualche+nounSG* and once with *alcuni+nounPL*. One hundred and eighty control stimuli with a semantic violation were also included. Twenty-six participants were asked to press one key if the phrase matched with the picture, another key in the opposite case.

We analyzed ERPs time locked to the presentation of the noun, using a Mass Univariate Statistics approach. We found no differences as for *un+nounSG* conditions. Instead, nouns following both *qualche* and *alcuni* elicited a larger Left Anterior Negativity (LAN) after a picture presenting one object than after a picture displaying four objects. The picture-phrase incongruences with semantic violations showed a clear N400 effects, with different topographic effects from LAN. Considering the LAN as an index of morphosyntactic incongruence, this result seems to suggest that 1) the reference to a numerosity could be incrementally encoded, and 2) the morphological Number value of plural has a narrower interpretation than the singular. Furthermore, the results of the present experiment suggest that picture-phrase incongruences can be used to fruitfully disentangle morphological and semantic effects.

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Cerebellar Direct Current Stimulation (tDCS) for the treatment of Phantom Limb Pain (PLP): a psychological and neurophysiological study

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Background: non-invasive brain stimulation techniques, as repetitive Transcranial Magnetic Stimulation and tDCS have recently emerged as promising tools for modulating pain experience. In previous studies, we have proved that cerebellar tDCS modulates nociceptive processing and pain perception, suggesting for the first time that cerebellum is strongly engaged in the sensory-discriminative, as well as in the affective/emotional and cognitive dimensions of pain.
Objective: the primary aim of this study is to evaluate the possibility to modulate nociceptive processing and pain perception with cerebellar tDCS in patients suffering from PLP.
Materials and Methods: patients underwent cerebellar tDCS (anodal or sham, 2.0 mA, 20' per day, five days a week). Inclusion criteria are: 1) age older than 18 years; 2) unilateral lower limb amputation; 3) average pain of at least 4 on a numeric rating scale; 4) any medications dosages stable for at least two weeks prior the study. Clinical scores and electrophysiological parameters were assessed before tDCS, at the end of 5-days treatment, two weeks and one month after tDCS completion. Changes in Visual Analogue Scores (VAS) was evaluated (chronic pain, paroxysmal pain, stump pain, telescoping, phantom movements). LEPs were obtained using a Nd:YAP laser (wavelength 1.04 µm, pulse 164 duration 2–20 ms, maximum energy 7 J). The amputated limb was stimulated by laser pulses with short duration (5 ms) and small diameter spots (5 mm). Statistical analysis was performed on Prism software using non parametric analysis of variance for paired data (Friedman test), to measure changes in VAS scores and LEPs overtime. HADS, SF-36 and BPI were administered to each patient, in order to evaluate the effect of PLP on psychological well-being, daily living and the efficacy of the treatment to improve quality of life and to reduce perception of pain.
Results: anodal tcDCS significantly reduced non painful phantom limb sensations ($p < 0.0006$) and paroxysmal pain ($p < 0.042$) compared with sham polarization, with effects lasting for three weeks after protocol completion; no change overtime was found in Phantom Limb Pain ($p = 0.25$), Stump Pain ($p = 0.25$) and telescoping scores ($p = 0.07$). Concurrently, anodal polarization significantly dampened LEP amplitudes (N1 and N2/P2, $p < .01$), whereas sham intervention left them unchanged.
Conclusion: anodal tcDCS significantly reduces non painful phantom limb sensations and paroxysmal pain, whereas it doesn't' have significantly effect on phantom limb pain, stump pain and telescoping. This study gives us the opportunity to integrate for the first time the psychology and neurophysiology to evaluate patients with PLP.

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Cerebellar and Spinal DC stimulation do not modulate the P300 component

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Introduction: The P300 component are considered a direct indicator of a subject's stimulus evaluation and speed of information processing. In this study, we aimed to investigate the effects of cerebellar and spinal direct current stimulation (tDCS) on the P300 component elicited by the auditory oddball task.
Material and Methods: We enrolled forty healthy subjects (15 M and 25 F, aged 20-50 years) which were randomly assigned to one of four stimulation conditions. First group (n=10) received anodal cerebellar tDCS with the reference electrode over the right shoulder; second group (n=10) anodal spinal tDCS with the reference electrode over the right shoulder; third group (n=10) anodal spinal with cathodal cerebellar tDCS; forth group (n=10) sham stimulation. Stimulation intensity was set at 2mA and delivered for 20 minutes. Before (T0) and after five (T1) and thirty minutes tDCS (T2), P300 were measured by attaching an electrode to Cz area according to the International 10-20 System in an auditory oddball task. The oddball discrimination paradigm consists in a presentation (binaurally through headphones) of discrete stimulus tones at an intensity of 75 dB and duration of 100 milliseconds. We presented two blocks of 100 stimuli, 25 target tones (2000 Hz) and 75 non-target tones (1000 Hz) with a fixed ISI of 1 second. Participants were required to count only to the target stimuli.
Results: We found that tDCS failed to induced significant differences in P300 latency [(mean ± SD) cerebellar tDCS: T0 337.88±28.49 vs T1 328.46±30.91 vs T2 335.92±29.31 p>.05; spinal tDCS: T0 342.30±22.96 vs T1 340.30±17.08 vs T2 339.84±22.09 p>.05; cerebellar-spinal tDCS: T0 348.59±22.73 vs T1 349.22±31.65 vs T2 341.77±36.08 p >.05] and P300 amplitude (cerebellar tDCS: T0 14.46±6.8 vs T1 14.6±8.14 vs T2 13.45±6.38 p>.05; spinal tDCS: T0 12.79±4.33 vs T1 12.14±5.65 vs T2 10.08±5.83 p>.05; cerebellar-spinal tDCS: T0 12.95±7.16 vs T1 12.37±7.29 vs T2 11.03±4.29 p>.05).
Discussion: Our results showed that tDCS had no significant effects on P300 component probably because competing mechanisms of inhibitory and executory mechanisms in several brain region may be at play when tDCS is operational, thus not allowing for a consistent outcome. Further research should tested the recent computational models combined with different stimulation parameters in order to better understand tDCS impact on EEG.

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Fatigue in Parkinson's disease is associated to attentional dysfunction: a P300 study

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Central fatigue is defined as a failure to initiate and sustain attentional and physical tasks that require self-motivation. Patients with Parkinson's disease (PD) report a high prevalence of fatigue, which has a significant negative impact on quality of life. It has been suggested that fatigue is associated to a dysfunction in the striato-talamo-prefrontal loop, and that it could be related to the cognitive domain. The P300 is the most studied ERP component for exploring attentional functioning, and is elicited by unpredictable, infrequent and salient changes in stimulus characteristics, the P3a being present when these changes are unexpected and novel, the P3b when they are task-relevant. The aim of the present study was to explore the association between fatigue and attentional function in patients with PD.
16 non-demented PD patients without fatigue-PDnF, 10 non-demented PD patients with fatigue - PDF and 18 age and sex-matched controls underwent a P300 novelty task. N1, P3a, and P3b components were measured and amplitudes and latencies were analyzed separately by means of a mixed model ANOVA for repeated measures.
N1 latency and amplitude were comparable between groups. A significant difference between groups emerged both for P3 latency (P3a: $p<0.001$; P3b:$p=0.03$) and P3amplitude (P3a: $p=0.046$; P3b:$p=0.034$).
As regards P3a latency, after Bonferroni correction, PDF patients displayed a significant more prolonged P3a latency respect to both controls ($p<0.001$) and PDnF ($p=0.04$); moreover a difference bordering on significance emerged also between PDnF and controls ($p=0.09$). As regards P3a amplitude, after Bonferroni correction, a significant difference emerged only between PDF and PDnF ($p=0.045$) with PDF displaying a significant lower amplitude respect to PDnF.
As regards P3b latency, after Bonferroni correction, a significant difference emerged only between PDF and controls ($p=0.027$) with patients displayed a significant more prolonged P3b. As regards P3b amplitude, after Bonferroni correction, a difference bordering on significance emerged between PDnF respect to both PDF ($p=0.09$) and controls ($p=0.068$), with PDnF displaying a larger P3b amplitude.
PDF specifically showed a difficulty in the attentional switching to salient novel stimuli, which is related above all to functioning of the fronto/parietal brain areas and the ventral attention network, and mediated by dopaminergic activity. Moreover, their ability to discriminate the significant target stimulus that requires the integrity of the dorsal attentional network is also compromised. In PDnF, instead, the stimulus categorization seems to require more attentional effort in order to be performed in an adequate amount of time. These data point to a possible association between fatigue and attentional dysfunction. A more altered striato-thalamo-prefrontal loop may contribute to the pathogenesis of central fatigue in PD.

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Trial latencies estimation of event-related potentials in EEG by means of genetic algorithms

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Objective

Event-Related Potentials are usually obtained by averaging thus neglecting the trial-to-trial latency variability in cognitive EEG responses. As a consequence the shape and the peak amplitude of the averaged ERP are smeared and reduced, respectively, when the single trial latencies show a relevant variability. To date, the majority of the methodologies for single-trial latencies inference are iterative schemes providing sub-optimal solutions, the most commonly used being the Woody's algorithm.

Approach

In this study, a global approach is developed by introducing a fitness function whose global maximum corresponds to the set of latencies which renders the trial signals most aligned as possible. A suitable genetic algorithm has been implemented to solve the optimization problem, characterized by new genetic operators tailored to the present problem.

Main results

The results, on simulated trials, showed that the proposed algorithm performs better than Woody's algorithm in all conditions, at the cost of an increased computational complexity (justified by the improved quality of the solution). Application of the proposed approach on real data trials, resulted in an increased correlation between latencies and

Significance

The above mentioned results on simulated and real data indicate that the proposed method, providing a better estimate of single-trial latencies, will open the way to more accurate study of neural responses as well as to the issue of relating the variability of latencies to the proper cognitive and behavioral correlates.

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EEG indices of performance monitoring activity and error predictability: embodying the actions of an avatar in immersive virtual reality

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To detect errors in owns and others' actions is a crucial ability for an adaptive and flexible behavior. Midfrontal theta oscillatory activity (4-8Hz) is a well-established marker of committed or observed errors. By combining EEG and immersive virtual reality (IVR-CAVE system), we previously reported that observing errors in reach-to-grasp actions of an avatar seen from a first-person perspective elicited greater theta oscillations over fronto-central electrodes (Pavone et al., 2016). Recent findings from our laboratory, linked the general sense of Embodiment with electro-cortical signatures, showing that the mere observation of actions executed in first person perspective induces a sensation of Ownership (i.e., the feeling that an artificial agent is part of the body of the observer) and Agency (i.e., the feeling of being able to control its movement). However, former studies on observed errors used sequences of trials were erroneous actions were less frequent than correct actions (e.g. 30% vs 70%). Therefore, it was not possible to disentangle whether the activation of the performance system was due to an error - as a violation of the intended goal - or to surprise/novelty effect associated with rare and less predictable events. To address this issue, we recorded the EEG signal of 23 participants observing correct or erroneous actions performed by an avatar in first-person perspective. Importantly and differently from Pavone et al. (2016) the proportion of erroneous vs correct actions was 70% vs 30%. The results show that the observation of erroneous actions induced greater theta compared to correct actions. Additionally, correct trials reveal stronger alpha suppression than erroneous trials, in line with previous works. A similar result in the alpha band is reversed compared to Pavone et al. (2016), revealing alpha sensitivity to the frequency of observed stimuli.
Taken together, our data suggest that error monitoring, despite its percentage of occurrence, triggered the activity of the performance monitoring system, likely to flexibly adapt actions to the challenges of the external environment.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381867_RL5LX8lSA0.jpeg
Caption 1: Theta power (4-8Hz) at electrode FCz. The power is greater in the Erroneous compared to Correct condition after the end of avatar's action (300ms).

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The role of the right and left hemispheres in performing simple calculations: an MEG study

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It is common knowledge in clinical neuropsychology that the left hemisphere (especially the left parietal lobe) is crucial for number processing and calculation. Traditionally, impairments in mental or written operations after right hemisphere damage have been dismissed as the mere consequence of the impairment in spatial attention. However, recent results suggest that the role of right hemisphere may have been overlooked (Semenza et al., 2016, Benavides-Varela et al., 2014; 2016) and that the right hemisphere may be more relevant than previously thought. In the present MEG study we present further evidence supporting the idea that the right hemisphere can be crucial even in simple calculation in which spatial abilities are not crucially involved.
We tested 22 healthy participants, performing a simple arithmetic task (tables). Participants were asked to retrieve the correct results of a table entry (for example 6 x 3).
Results showed that faster and more efficient responses were reliably associated with higher activation of the left and the right parietal lobes, and in the right frontal lobe.
These results suggest an important role of right hemisphere in calculation even in tasks requiring minimal involvement of spatial attention. Together with the growing data from the literature, the evidence from this study corroborates the importance of the right hemisphere in number processing.

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Ideological priming-mediated effects over politically nonaligned people's deceptive behaviour: An eye tracking study

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The growing scandals and episodes of corruption involving politics have led to an increase of political abstentionism among voters and to the diffusion of protest movements. Thus, understanding whether and to what extent political ideology still plays a role in people's decision making and behaviour is crucial. By combining an ideological priming procedure with the 'Temptation to Lie Card Game' (TLCG), an experimental task where participants spontaneously choose whether to lie or not to another player, we tested the impact of the two major political ideologies –i.e. Conservatism and Liberalism- on moral decision making of politically nonaligned participants'.

In separate blocks we primed 50 politically nonaligned participants with different stimuli (faces of conservative vs liberal politicians and words that can be associated to one of the two ideological categories) before playing the TLCG with some high vs low status players. In addition to the behavioural response, participants' oculomotor behaviour was recorded.

Regardless of the type of the priming, participants made more egoistic lies (produced to increase their payoff) to high status players and more altruistic lies (produced to share their payoff) to low status players.

Oculomotor behaviour revealed that when provided with visual competing information regarding the status of the other player and the outcome of the game (win/lose) , participants tended to look more at the status of the player (high/low) after a Liberal priming. Conversely, when primed with a Conservative stimulus, participants tended to look more at the outcome of the game and, moreover, to lie less to high status players. In addition to that, Liberal priming led participants not only to take more time to decide whether to lie or not, but also –once they decided- to avoid the eye contact with the low status player's picture shown at the end of each trial, suggesting some sort of feeling of shame.

Although the ideological priming procedure does not show direct increase/decrease in participants' tendency to lie, implicit indicators measured during the TLCG (i.e., participants' oculomotor behaviour and temporal latency of the decision) seem to suggest that the two opposite ideologies differently influences social decision making towards people of different social status. This may be in keeping with previous research showing that endorsing a liberal ideology leads to a higher sensitiveness to social inequality and support for redistribution of richness, while conservative ideology is associated to maintaining the status quo and justifying the differences among people based on meritocracy.

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Predictive value of EEG-based functional connectivity measures on the outcome of a task-specific rehabilitative treatment in Multiple Sclerosis patients

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Introduction. Previous work indicates that Multiple Sclerosis (MS) patients are characterized by significant alterations in brain functional connectivity relative to healthy control subjects of matched gender and age. However, the potential relationship between connectivity measures and functional improvement induced by rehabilitative strategies still remains unknown. Here, we specifically explored such interactions for two popular EEG-based connectivity measures: the weighted Phase Lag Index (wPLI) and the weighted Symbolic Mutual Information (wSMI). These two measures account for different neural source dynamics, such as linear or non-linear interactions. Thus, we hypothesized that wPLI and wSMI may account for different aspects of training-related motor recovery in MS patients.
Methods. Sixteen MS patients completed a two-week task-oriented circuit training (TOCT) period. The Time Up and Go (TUG) test was used to assess relative variations in motor performance. Before (T_0) and after (T_1) the training period patients completed a 10-min EEG resting-state recording (64 electrodes; Micromed) with eyes closed. For each EEG recording, a single index of 'global' (whole-brain) connectivity strength was computed as the average (median) of wPLI (wSMI) connectivity values for all channel combinations. To evaluate the relationship between connectivity values at T_0 or T_1, or connectivity variations T_1-T_0, and improvements in motor performance (ΔTUG), an ANCOVA model was used, in which patients' age was included as confounding variable.
Results. We observed a significant correlation between the alpha-band (8-12Hz) wPLI connectivity and the mobility measure ΔTUG, both at T_0 (Figure 1a; $r = 0.66$; $p = 0.0074$) and at T_1 (Figure 1b; $r = 0.60$; $p = 0.022$). However, no significant correlation was observed between T_1-T_0 variations in connectivity and ΔTUG ($r = -0.055$, $p = 0.85$). Further analyses showed that the relationship between wPLI connectivity and performance improvement was stronger for anteroposterior than interhemispheric connectivity. The whole-brain broadband (1-45Hz) wSMI connectivity was found to be correlated with ΔTUG at T_1 ($r = 0.67$; $p = 0.0090$; Figure 2a) but not at T_0 ($r = 0.23$; $p = 0.44$). Finally, a strong correlation was observed between the T_1-T_0 variation in wSMI connectivity and ΔTUG, with $r = 0.70$ ($p = 0.0053$; Figure 2b).
Conclusions. Our observations suggest that the tested connectivity measures account for different aspects of training-related functional changes. In particular, alpha-band-wPLI may represent a good indicator of whether a patient will positively respond to treatment, but does not reflect treatment-based changes in neural activity. On the contrary, broadband wSMI seems to account for changes induced by the treatment (increase in system complexity). Changes in broadband wSMI connectivity likely reflect the implementation or unmasking of (compensatory) mechanisms that are not active in patients before treatment.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_386223_GcGKGbsQ8g.jpg
Caption 1: Figure 1a) and b). Correlation between alpha-band wPLI connectivity and ΔTUG at T0 (left; r=0.66,p=0.0074) and T1 (right; r=0.60; p=0.022).

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img2_386223_GcGKGbsQ8g.png
Caption 2: Figure 2a) and b). Correlation between wSMI at T1 (left; r=0.67,p=0.0090), T1-T0 wSMI changes and ΔTUG (right; r=0.70; p=0.0053).

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Autonomic effects of acupuncture on consciousness disorders: a pilot study

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Patients with disorders of consciousness (DOCs), besides presenting with motor, sensory, cognitive and behavioural impairment, are prone to autonomic nervous system (ANS) imbalance, severely impacting on their prognosis *quoad vitam* which may be due to a dysfunction of the central neuromodulatory systems that regulate vigilance states and neuroplasticity. Restoration of autonomic function may represent a challenge for the treatment of these patients. Employed mainly as analgesic technique, acupuncture has been shown to act at various levels of nervous system and to modulate the ANS [1,2]. In this work we report the effects of acupuncture on the autonomic system of DOCs patients, studied in the rest state as well during an EEG event-related potential (P300) through the analysis of Heart Rate Variability (HRV). We additionally describe variations in the clinical scales of consciousness (CRS-R) and blink rate, as behavioural epiphenomenon of attentional process [3].

Patients and Methods
Six subjects (5 males) affected by DOCs (2 Vegetative, 4 Minimally Conscious State) of various origin (2 traumatic, 3 anoxic, 1 hemorrhagic) were enrolled after the informed consent of the family. Bipolar ECG (V6 and Rt shoulder electrodes) for HRV analysis, 64 ch EEG and bipolar EOG (vertical electrodes) for the evaluation of blink rate were recorded with a Micromed poligraph, both in resting state (30 min) and during a P300 passive oddball paradigm (5 min) before and after a specific 5-points acupuncture protocol. HRV was analyzed by Kubios software. The parameters extracted during rest and P300 periods, before and after acupuncture, were compared by a Wilcoxon Test.

Results
Clinically (CRS-R) the behavioural state did not widely change; however, during rest, a modification in blinking rate was reported in 4/6 subjects following acupuncture, with respect to the pre-acupuncture values (6.2 ±14.7 vs 3.2 ± 30.2). As regards the effects on ANS, during rest, acupuncture induced a significant increase in the root mean square differences of successive R-R intervals (RMSSD), which is a time domain measure of heart period variability (table 1)..
Moreover during the P300 stimulation paradigm a comparison between pre- and post-acupuncture values revealed a trend towards parasympathetic activation following acupuncture, indicated by the increased high frequency (HF) band power (table 1).

Conclusions

Given its safety, acupuncture could represent an interesting technique able to modulate ANS, in particular

increasing RMSSD, which can represent an index of environmental adaptability. As free of side effects or drug interactions, it is indicated for such fragile subjects. Further studies are needed to identify the most efficient and customized therapeutical protocol and to investigate its long-term effects.

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Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_386208_J1QCwqrpym.png
Caption 1: Autonomic parameters measured by HRV analysis in resting state (*) and during ERP (**) significantly changed after acupuncture session

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Understatement of Olfactory Electrophysiological Response as cue in Mild Cognitive Impairment

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Olfactory perception is compromised in Alzheimer's disease (AD). Olfactory involvement is present up to 90% of patients with AD. In the early years of AD, olfactory dysfunction may involve the conversion of Mild Cognitive Impairment (MCI) into AD. MCI is a diagnostic label defining cognitive syndrome that indicates a transient phase, between normal aging and dementia. Populations affected by MCI have a higher risk of developing dementia than the general population. Based on these assumptions, the purpose of this study was to investigate olfactory perception in MCI patients, to carry out an olfactory assessment through the registration of Olfactory Event Related Potentials (OERP). We recruited 12 MCI subjects (mean age 70 years; SD ± 7.71), scored with the MMSE (Cut off: <24), Trial Making Test (TMT), Corsi Test (CT), Digit Span (DS) and Rey Auditory Verbal Learning Test (RAVLT); patients were recruited in the Neurology Unit, in Alzheimer Assessment Unite (UVA Center). The control group (HS) consisted of 12 controls (mean age 64 years; SD=6), scored with MMSE (Cut off:>24), TMT, CT, DS, RAVLT, recruited as volunteers. Subjects performed an olfactory recognition task of two odorant: Rose and Eucalyptus, placed in 5 ml Vials. The vials were administered via the patented VOS EEG MI2014A001344. The presentation paradigm was an oddball olfactory task. Each stimulation lasted 450 ms, the duration of the ISI was 60 seconds, the total duration of the task was about 40 minutes [6 trials of S1- Rose smell (RC) and 18 of S2 Eucalyptus smell (EC)]. The subject's task consisted to breathe and smell in a Black Cave during an EEG Recording. N1 and LPC OERPs components were investigated. Statistical analyses were performed using linear mixed-effects models. We found significant effect ($\alpha<0.05$) in Amplitude on: group ($\chi^2 = 6.06$), Odor ($\chi2 = 106.80$), ROI ($\chi2 = 9.29$), interaction group * Odor ($\chi2 = 57.4$) and the interaction Odor * ROI ($\chi2 = 33.54$). The HS presented greater amplitude than MCI ($\beta = -2.27$, $t = -2.41$); the MCI group showed a smaller N1 in Rose condition ($\beta = 2.14$, $t = 2.58$, $p <0.01$); furthermore, in HS, N1 decreased in Posterior Right ROI in EC. Main Effect on LPC component was found on group ($\chi2 = 10.42$), group * ROI ($\chi2 = 5.48$), group * ROI * Odor ($\chi2= 72.42$). The HS, vs MCI, presented: a decrease N1 in EC than the RC ($\beta = -2.42$, $t = -4.55$, $p <0.01$); LPC increased in RC ($\beta=5.93$, $t=6.37$, $p <0.01$); in Parietal Right ROI presented a decreased LPC in EC ($\beta = -2.44$, $t = -2.74$); finally HS showed an increased LPC in Parietal Left ROI in EC ($\beta = 6.07$, $t = 6.46$). Results of this research could indicate that, in the MCI subjects, both the OERP sensory components (N1) and those most properly related to the cognitive aspects (i.e., LPC) due to olfactory stimulation, tend to be less activated during an olfactory recognition task. A further step in the study will be to investigate olfactory response in AD, comparing it with MCI.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_386316_IBn6zyz9tl.jpg

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THE MUTUAL RELATIONSHIP BETWEEN MOVEMENT AND PAIN: A STUDY BY FUNCTIONAL NEAR-INFRARED SPECTROSCOPY AND LASER EVOKED POTENTIALS IN NORMAL SUBJECTS AND FIBROMYALGIA PATIENTS

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Recent studies suggested that the activation of motor cortex can decrease subjective pain and nociceptive induced brain responses in patients with chronic pain. Physical exercise would seem to improve quality of life and fitness of patients with Fibromyalgia (FM), an invalidating disorder characterized by chronic diffuse muscle-skeletal pain. This study aimed to examine the interaction between the activity of motor and somatosensory cortex during concurrent painful stimulation and motor task in FM patients and control subjects. The simultaneous recording by functional Near Infrared-Spectroscopy (fNIRS) and Laser Evoked Potentials (LEPs) was used to evaluate the effects of motor cortex activity on the subjective pain and LEPs. The fNIRS is a portable optical method to detect cerebral hemodynamic changes in real time. We used 20 fNIRS channels positioned on the primary motor cortex according to Predefined Montage Tab by NIRStar 14.2. and 63 scalp electrodes for LEPs recording. The experimental protocol consisted of a basal session of 30 laser stimuli delivered over the right hand back, followed by analogue stimulation modality during a concurrent finger tapping task. The participants were 23 patients with FM (4 males and 19 females, M_{age} =43,17 SD=10,56 , age range from 23 to 60) and 13 healthy subjects (5 males and 8 females, M_{age}=37,38 SD=15,50, age range from 19 to 60). The analysis of fNIRS data confirmed the activation of primary motor cortex both in patients and controls during finger tapping task. A significant reduction of oxyhemoglobin levels corresponding to the contralateral motor cortex was present in FM patients during fast movement with a trend toward reduced changes during concurrent laser stimulation. The finger tapping speed was reduced in patients and independent from concurrent laser stimulation. The N1 amplitude was reduced during movement in patients and controls, with a similar trend for the N2P2 complex. There was a trend toward reduced changes in patients. In FM patients the general level of motor activation was reduced, as for effect of a chronic inhibition. A trend toward a reduced modulation of both N1 and N2P2 components emerged during fast movement, thus preliminary confirming the self sustained circuit of pain persistence and motor inhibition. The study confirmed the mutual relationship between motor and nociceptive cortex, as physical activity may be considered a beneficial support in pain control.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381876_Mib1aeZyEx.jpg
Caption 1: Oxyhemoglobin concentration in one FM Patient and in one Control Subject

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Feeling and observing movements: the interaction between kinesthetic illusion and action observation

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It is well known that the acquisition of new motor abilities depends heavily on movement execution. However, recent evidences pointed out the role played by action observation (AO) in acquiring new motor skills and evoking cortical plasticity. These phenomena could happen only when AO immediately precedes or is concurrent to movement execution, or when peripheral electrical stimulation congruent with the observed action are delivered during AO.
In the present study, we combined action observation with the sensory afferent signals specific for movement execution, i.e. the proprioceptive information coming from the lengthening muscle, which was generated by means of a mechanical vibration able to evoke a kinesthetic illusion (KI) of movement. The proprioceptive stimulation was delivered by means of a proprioceptive stimulator positioned over the extensor pollicis brevis muscle, the latter generating an illusory sensation of thumb abduction. The experiment was composed of two conditions where the observed action and the afferent signal could be either congruent or incongruent. In the congruent condition (AO-KI CONGR) participants observed a 10-sec video showing the thumb abduction of the right hand (generated by the activation of the abductor pollicis brevis muscle - APB), whilst in the incongruent condition (AO-KI INCONGR) they observed a thumb adduction. The activity of the primary motors cortex (M1) in correspondence to the APB muscle area was evaluated by means of recruitment curves before, immediately after, and 30 and 60 minutes after the end of the stimulation. The results showed a significant increase of the M1 excitability, as measured by the slope of the recruitment curves, that lasted until 60 minutes after AO-KI CONGR. No differences were observed before and after the administration of AO-KI INCONGR. Furthermore, in a control experiment we tested whether this effect was specific for the kind of sensory input, and a tactile vibration was delivered during the observation of thumb abduction. This protocol did not evoke any changes in M1 excitability. Following these results, we proposed that AO, when combined to KI evoked by a proprioceptive stimulation, was able to evoke plastic changes in M1 activity. These results candidate AO-KI as possible methodology to train the motor system without moving.

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New frontiers in language recovery: Transcutaneous Spinal Direct Current Stimulation (tsDCS) in chronic post-stroke aphasia

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Over the last 20 years, major advances in cognitive neuroscience have clearly shown that the language function is not restricted into the classical language areas but it involves brain regions, which had never been considered before. Indeed, recent lines of evidence have suggested that the processing of words associated to motor schemata, such as action verbs, modulates the activity of the sensorimotor cortex, which, in turn, facilitates its retrieval. To date, no studies have investigated whether the spinal cord, which is functionally connected to the sensorimotor system, might also work as an auxiliary support for language processing. We explored the combined effect of transcutaneous spinal direct current stimulation (tsDCS) and language treatment in a randomized double-blind design for the recovery of verbs and nouns in fourteen chronic aphasics. During each treatment, each subject received tsDCS (20 min, 2 mA) over the thoracic vertebrae (10th vertebra) in three different conditions: (1) anodic, (2) cathodic and (3) sham, while performing a verb and noun naming tasks. Each experimental condition was run in five consecutive daily sessions over 3 weeks. Overall, a significant greater improvement in verb naming was found during the anodic condition with respect to the other two conditions, which per-sisted at 1 week after the end of the treatment. No significant differences were present for noun naming among the three conditions. The hypothesis is advanced that anodic tsDCS might have influenced activity along the ascending somatosensory pathways, ultimately eliciting neurophysiological changes into the sensorimotor areas which, in turn, supported the retrieval of verbs. These results further support the evidence that action words, due to their sensorimotor semantic properties, are partly represented into the sensorimotor cortex. Moreover, they also document, for the first time, that tsDCS enhances verb recovery in chronic aphasia and it may represent a promising new tool for language treatment.

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Co-expression of schizophrenia genes in the thalamus and prefrontal cortex is associated with thalamo-prefrontal connectivity during attentional control

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Attentional deficits are core cognitive symptoms of schizophrenia (SCZ). During attentional control, lower functional connectivity between the thalamus and the prefrontal cortex (PFC) is found both in patients with SCZ and in their healthy siblings. While this evidence suggests a familial basis of thalamo-PFC dysfunction, its molecular and genetic underpinnings are still unclear. Since co-expression of genes across brain areas promotes synchronous network-level activity, we hypothesized that the co-expression of SCZ risk genes in the mediodorsal thalamic nucleus (MD) and PFC may be associated with synchronous thalamo-PFC activity during attentional control.
We used three *post mortem* mRNA expression datasets to identify genes with coordinated MD-PFC expression (Kendall's Tau, Bonferroni p<.05) and to identify and validate a PFC co-expression network. Then, we prioritized gene sets by their enrichment for genes with coordinated MD-PFC expression and for genes localized in Psychiatric Genomic Consortium loci of SCZ risk. To link this gene set with imaging phenotypes, we identified single nucleotide polymorphisms (SNPs) predicting its co-expression. We combined the SNPs into a Polygenic Co-Expression Index (PCI) and computed this index for healthy participants (N=265) who performed an attentional control task during fMRI and were genome-wide genotyped. We conducted Independent Component Analysis (ICA) and selected Independent Components (ICs) spanning across the thalamus and the PFC, and an attentional control network. Finally, we investigated the association between the PCI and thalamo-PFC functional connectivity during attention by means of multiple regressions.
One of the 67 coexpression gene sets detected was enriched for coordinated MD-PFC expression and for SCZ risk genes. This gene set included 312 genes (15 with coordinated MD-PFC expression and 15 SCZ risk genes – Bonferroni-corrected p<.05). A single gene, *SRR*, was common to the MD-PFC and SCZ risk gene lists. Gene ontology enrichment analysis revealed that this gene set was also enriched for genes involved in neurodevelopment (Bonferroni corrected p value=0.03).
ICA extracted 45 COIs and 5 resulted spatially correlated with the attention network (R^2>0.01). All 5 COIs included both the thalamus and the PFC (t-test, p<.05, FWE corrected). The PCI was positively associated with thalamic connectivity strength (MNI coordinates: -10, -14, 6; Z=4.6; cluster extent=6 voxels) within a COI encompassing PFC, parietal cortex, thalamus, insula and putamen.
These findings support the association between SCZ risk genes and thalamo-PFC connectivity, and the relationship between gene expression co-ordination across brain regions and functional connectivity between them. Gene co-expression seems to be a plausible biological mechanism of genetic risk for SCZ. Findings also highlight the role of *SRR* in SCZ-related alteration of thalamo-PFC connectivity.

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EXTRAVERSION AND BEHAVIOURAL APPROACH SYSTEM IN THE STIMULUS ANALYSIS AND MOTOR RESPONSE INITIATION

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Previous reports (Rammsayer & Stahl, 2004; Stahl & Rammsayer, 2008; Houlihan & Stelmack, 2011), using a visual letter discrimination task with a go/no-go procedure, reported longer stimulus-locked lateralized readiness potential (S-LRP) and shorter response-locked LRP (R-LRP) for extraverts than introverts to simple imperative stimuli to respond. Aim of this pilot study was to replicate these Extraversion/ERP findings and to extend them into Behavioral Approach System (BAS) subtraits within the framework of the revised-Reinforcement Sensitivity Theory (r-RST) of personality (Gray & McNaughton, 2000; McNaughton & Corr, 2008). Here, we assessed psychological traits of Extraversion (E), and four BAS subtraits (Goal drive Persistence, Reward Interest, Reward Reactivity and Impulsivity; Corr and Cooper, 2016) measures in 51 women volunteers. Lateralized readiness potentials (LRPs), dorsal surface forearm electromyogram (EMG), and event-related potentials (ERPs), were recorded during the performance of a two-choice Go/NoGo visual letter/number discrimination task varying in task difficulty. Measures of RT and response variability were obtained as behavioral performance indicators. We failed to find individual differences in R-LRP measures for Extraversion and BAS facets. Instead, we observed shorter S-LRP latencies in extraverts compared to introverts and high BAS-RI compared to low BAS-RI participants. We speculate that stimulus analysis, being shorter in the more difficult task, was abbreviated for extraverts and high BAS-RI participants owing to their disposition for faster cortical premotor initiation. Extraverts and high BAS-RI individuals also had shorter stimulus-locked S-EMG and response-locked R-EMG responses, indicating faster peripheral motor response initiation and motor response execution in these individuals. Peak latency measures of stimulus-locked N2- and P3-ERP waves did not demonstrate significant individual differences in E and BAS facets. However, both extraverts, and higher BAS-RR and BAS-I participants had smaller P3 amplitude compared with those of the opposite pole ones. These findings were seen as indicating the reduced perceptual processing capacity and strength of response selection in these individuals.

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ERP modulations associated with no-movement awareness: P300 and N400 changes after long-term limb immobilization during a Go/Nogo task

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The present study focused on the physiological processes underling the no-movement awareness (i.e. the conscious detection of the impossibility of accomplishing self-generated actions). We investigated the electroencephalographic (EEG) activity of healthy participants performing a Go/Nogo task, by contrasting conditions in which participants were free to perform the task with conditions in which left hand movements were prevented by a cast. The immobilization effect was tested as soon as the cast was positioned and after one week of immobilization. In blocked conditions, when the subjects were asked to perform the Go/Nogo task but the cast prevented the movement execution, a no-movement awareness related modulation on the EEG activity should be expected as a consequence of the presence/absence of the cast and the duration of the immobilization. Sixteen healthy participants underwent 4 EEG sessions and the mean ERP at midline locations (Fz, Cz, Pz) were analyzed separately on *nogo* (stimulus-locked) and *go* (movement-locked) trials with a 2x2x2 Anova with Side (Left; Right), Time (Day1; Day2) and Cast (Free; Blocked). In *nogo* trials, a significant Side*Cast interaction ($p<0.01$) was found in the P300 component, known to be related to response inhibition. Only in the left (manipulated) side, the P300 amplitude was significantly reduced in blocked with respect to free conditions. This means that, irrespective of the duration of the immobilization, when the system “knows” that no movements can be performed, inhibitory responses appear to be useless and therefore are not implemented. In *go* trials, a significant Side*Day*Cast interaction ($p<0.01$) was found in the N400 component, known to be related to semantic violations, elicited when a meaningful stimulus is incongruent within the context. In our study, a violation could be detected by the motor monitoring system when, according to *go* signals, a motor response was planned but no movement was performed (due to the cast). In the left (manipulated) side, the N400 amplitude is oppositely modulated by free and blocked conditions, depending on the day. In blocked conditions, the N400 amplitude was larger at day 1, as soon as the hand was immobilized by the cast and the motor monitoring system suddenly detect a mismatch between intended but not executed response. At day 2, after long-lasting immobilization, the motor monitoring system, having changed its prediction according to the learned block, did not show the enhancement as if no incongruences had to be detected when no movements were performed. On the contrary, in free conditions, the N400 amplitude was significantly larger at day 2 when a new incongruence appeared, between no-movement predictions and the evidence of being able to move again after the cast removal. Taken together, these findings show that mechanical limb immobilization is a good model to investigate the EEG activity changes related to the no-movement awareness.

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Nociceptive system evaluation in patients with non suicidal self-injury (NSSI): a neurophysiological study with quantitative sensory testing and laser evoked potentials. Preliminary results.

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Introduction: Non-suicidal self-injury (NSSI) is the act of purposely harming one's own body tissue without the intent of suicide. Prevalence during adolescence is around 17-18%. Essential features are inability to resist the impulse to injure oneself, increased sense of tension prior to the act and experience of release/relief after the act (DSM IV). To answer the question asking how are these patients able to overcome the instinct to avoid pain, previous studies in Borderline personality disorder (BPD)-related self injury looked for a dysfunction in the nociceptive system and found a reduction in pain perception.
Since NSSI, according to the DSMIV, is now considered a self contained category, the aim of the present study is to assess whether it is associated with a dysfunction of the nociceptive system by recruiting a selected sample of adolescents (age11-18) meeting criteria for NSSI without any major psychiatric disorder.
Methods: We have currently enrolled 26 young women suffering from NSSI and 15 age-matched healthy controls. Each participant underwent quantitative sensory testing, including cold detection threshold, warm detection threshold, cold pain threshold and heat pain threshold, and laser evoked potential recording.
Results: To date quantitative sensory testing data and LEP variables did not differ between NSSI patients and healthy participants.
Conclusions: According to our preliminary results NSSI is not associated with a nociceptive system dysfunction.

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Cerebral grey matter density is reduced in chronic migraine patients: correlations with clinical features

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Background – Few MRI studies have been performed so far in patients affected by chronic migraine (CM) and especially in those without medication overuse. Here, we performed voxel-based morphometry (VBM) analysis to investigate the grey matter (GM) density of the whole brain in patients affected by CM. Our aim was to investigate whether there are fluctuations in the GM densities in relation to CM clinical features.
Methods – Twenty untreated CM patients without a past medical history of medication overuse underwent 3T MRI scans and were compared to a group of 20 healthy volunteers (HV). SPM12 and CAT12 toolbox were used to process MRI data and to perform VBM analysis of structural T1-weighted MRI scans. The patients' versus HV relative GM density was assessed with an uncorrected threshold of $p < 0.01$. To check for possible correlations, patients' clinical features and GM maps were regressed.
Results – Compared to HV, CM patients showed 4 clusters of significantly lower GM densities: I) right cerebellar lobules (VIIIa, CrusII), II) the left occipital areas (BA17/BA18), III) the left middle temporal gyrus, and IV) the left temporal pole /amygdala /pallidum /orbitofrontal cortex. The GM density of cerebellar hemispheres correlated negatively with the years of headache disease, and positively with the number of tablets intake per month.
Conclusion – In sum, CM is associated with lower GM density in several brain areas known to be involved in antinociception, multisensory integration, and analgesic dependence. The GM density within the cerebellum was significantly related to longer duration of headache disease and to higher consumption of acute headache medications. We hypothesize that the reduced GM density within the cerebellum may be considered, in conjunction with the results provided by a previous FDG-PET study showing a cerebellar hypermetabolism during medication overuse and its normalization after medication withdrawal, as a predisposing ground on which to develop medication overuse headache.

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Are nociceptive gamma-band oscillations recorded from the human insula related to the activation of the spinothalamic tract?

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Using intracerebral electroencephalography (iEEG), we recently observed that painful thermal stimuli, but not non-painful high-intensity tactile, auditory, and visual stimuli, elicit an enhancement of gamma-band oscillations (GBOs) in the human insula (Liberati et al. 2017, *Cerebral Cortex*, in press). This finding indicates that GBOs that are *preferential* for thermal nociceptive stimuli can be recorded from the human insula. Nevertheless, the functional significance of nociceptive GBOs recorded from the human insula is yet to be determined.
Importantly, the observed enhancement of GBOs could be due to different features of the stimuli, such as (i) the fact that they are nociceptive, (ii) their painful quality, (iii) the fact that they activate the spinothalamic system, or (iv) the fact that they convey thermal information. To disentangle these different aspects, we examined whether insular GBOs would be elicited by non-painful cool stimuli and non-thermal but painful mechanical pinprick stimuli.
iEEG was recorded in 7 patients undergoing a presurgical evaluation of intractable epilepsy, for a total of 64 insular contacts (33 left, 30 right). Four types of short-lasting stimuli were delivered on the contralateral hand dorsum: (i) painful 65°C laser stimuli activating heat-sensitive nociceptors; (ii) mechanical pinprick stimuli (96 mN) activating mechano-sensitive nociceptors; (iii) innocuous cool stimuli (10°C) activating cool-sensitive free nerve endings; and (iv) innocuous vibrotactile stimuli (250 Hz) activating mechanoreceptors of the medial lemniscus system (Figure 1).
In all patients, all four types of stimuli elicited clear low-frequency phase-locked local field potentials (LFPs). Consistently with previous findings, painful laser stimuli elicited an early latency (150-300 ms) enhancement of GBOs (40-90 Hz) at several insular locations. At those same insular locations, cool stimuli, but not pinprick and vibrotactile stimuli, elicited a similar enhancement of GBOs (Figure 2).
These data suggest that GBOs elicited in the human insulaby nociceptive stimuli could at least partly be related to the thermal quality of the stimuli, regardless of their painfulness.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_381798_wi3puAyS0H.jpg
Caption 1: Time-frequency maps showing gamma-band oscillations elicited in the insula

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_381798_wi3puAyS0H.jpg
Caption 2: A. Locations of insular electrodes. B. Types of stimulation

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Behavioral performance in a cognitive-motor task during learning processes in neurodegeneration: evidence from EEG network analysis

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Brain rhythms are linked to any kind of learning and the performance of any motor task. The brain is a complex network consisting of spatially distributed regions dedicated to different functions, and it is proposed that cognitive functions emerge from dynamic interactions of several brain areas. We have proposed here that the brain connectome can be a useful approach not only for elucidating mechanisms underlying brain cognitive functions, but also for detection of mental states. The aim of the present study was to use a learning task, in order to understand the possibility to predict the improvement of motor performance along physiological and pathological aging such as in neurodegenerative patients. 86 subjects were recruited, 22 Ctrl (, 47 aMCI, 17 AD. In this context, the introduction of neurodegenerative subjects could allow to collect all network deficit spectrum. EEG recordings were performed at rest, with closed eyes and no-task conditions (at least 5 minutes), both before and after the task. Brain network properties were described by Small World index (SW), which represents a combination of segregation and integration behavior. Correlation analyses showed that alpha 2 SW in pre period could predict behavioral learning ($r=-0.2592$, $p<0.0342$), namely lower alpha 2 SW, higher the learning as measured by the number of reached targets. Namely, lower the level of SW alpha 2 in this specific network, higher the possibility to increase its level during task and better the learning of this task and the number of reached targets. These results suggest that, by means of an innovative analysis applied to a low-cost and widely available EEG techniques (Small World from graph theory), the functional connectome approach as well as conventional biomarkers would be effective methods for boosting learning progress of learners due to training.

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Motor cortex synchronization influences the rhythm of motor performance

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Synchronization of neural activity improves data transmission and enhances timing accuracy within interconnected neural networks. In Huntington's disease, there is variable timing and coordination between sequences of actions requiring synchronization in neural activity of cortical motor areas. The aim of the present study was to examine synchronization in oscillatory activity of cortical motor areas in response to a strong external input produced by a pulse of transcranial magnetic stimulation (TMS). We combined TMS with EEG to compare the response of sixteen presymptomatic Huntington's disease patients (HD) with sixteen age-matched healthy volunteers (HV) to test whether strength of synchronization relates to the variability of motor performance at two tasks, i.e. a grip force task and a speeded tapping task. Phase synchronization in response to M1 stimulation was lower in HD compared to HV ($p<0.01$), resulting in a reduced cortical activity both at global ($p<0.02$) and local level ($p<0.01$). Participants who showed better timed motor performance, also showed stronger theta synchronization ($r=-.356$; $p<0.05$) and higher cortical activity ($r=-.393$; $p<0.05$). Our data may model the ability of the motor command to respond to more subtle, physiological inputs from other brain areas. This novel insight indicates that impairments of the timing accuracy of synchronization and desynchronization could be a physiological basis for some key clinical features of Huntington's disease.

Picture 1: https://www.eventure-online.com/parthen-uploads/175/17034/img2_382044_c7SPsWm0lO.png
Caption 1: Correlations between behavioral performance (ITI-SD), cortical activity (TMS-evoked P3) and cortical oscillations in the theta frequency (ITC-th)

Picture 2: https://www.eventure-online.com/parthen-uploads/175/17034/img1_382044_c7SPsWm0lO.png
Caption 2: TMS-evoked potentials from M1 of healthy volunteers (A) and Huntington's disease patients (B). Inter-trial coherence at global (C) and local level (D)

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Impaired Spike Timing Dependent Cortico-Cortical Plasticity in Alzheimer's disease Patients

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Mechanisms of cortical plasticity have been recently investigated in Alzheimer's Disease (AD) patients with transcranial magnetic stimulation (TMS) protocols showing a clear impairment of Long-Term Potentiation (LTP) cortical-like plasticity and a relative sparing of Long Term Depression (LTD) mechanisms. Here we aimed to investigate mechanisms of cortico-cortical spike-timing dependent plasticity (STDP) in Alzheimer's disease patients investigating the connections between posterior parietal cortex (PPC) and primary motor cortex (M1).

We used a cortico-cortical paired associative stimulation (cc-PAS) protocol to repeatedly activate the connection between the PPC and M1 of the left-dominant hemisphere in a sample of fifteen AD patients and in ten age matched healthy controls (HC). PPC TMS preceded (ccPAS +5) or followed M1 stimulation (ccPAS -5) by 5 ms. For the ccPAS protocol, 100 pairs of stimuli were continuously delivered at a rate of 0.2 Hz for ~ 8 min. We evaluated the effects of ccPAS protocols on the amplitude of motor evoked potentials, short intracortical inhibition (SICI) and short-latency afferent inhibition (SAI) protocols.

In HC ccPAS -5 protocol induced the expected long lasting increase of MEP amplitude compatible with LTP-like cortical plasticity while PAS+5 protocol induced the opposite effect, indicating a LTD-like cortical plasticity after effect. AD patients did not show any significant modification of the amplitude of MEP after both ccPAS protocols. SICI was not modified by any ccPAS protocol in both HC and AD patients' groups. At baseline AD patients showed altered response to the SAI protocol. Interestingly, ccPAS+ 5 protocol restored SAI levels in AD patients.

Our study shows that cortico-cortical STDP is altered in AD patients. PAS + 5 protocol is able to modulate SAI, suggesting a possible role of PPC-M1 pathway on modulation of sensory-motor integration pathway.