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AULA MAGNA VINCENZO LI DONNI
UNIVERSITÀ DEGLI STUDI DI PALERMO

BEYOND THE LOCKDOWN OF THE BRAIN

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GIOVEDI' 30 SETTEMBRE 2021

KEYNOTE LECTURE 1

FUTURE-ORIENTED COGNITION AND THE PREDICTIVE BRAIN

Giovanni Pezzulo

Abstract

There is increasing consensus around the idea that the brain is a predictive machine, which uses an internal generative model to continuously generate predictions, in the service of online action-perception and future-oriented forms of cognition. In this talk, I will present a theoretical and computational perspective on the functioning of the predictive brain, by appealing to the notions of 'predictive coding' and 'active inference'. In particular, I will focus on how the predictive brain may support prospective and future-oriented functions, such as planning and imagination, by temporarily detaching from the action-perception loop. I will highlight two distinct but complementary usages of planning in computational modelling that might be relevant to understand predictive brain functions: planning 'at decision time', to support goal-directed behaviour; and 'in the background', to learn behavioural policies and to optimize internal models. I will exemplify this distinction by presenting a series of simulations and by reviewing empirical evidence on internally generated sequences of neuronal activity in the hippocampus during online navigation and offline periods. The perspective offered in this talk suggests that the brain's generative model supports predictive and prospective functions even when it is temporarily detached from the action-perception loop; and this might have implications for our understanding of spontaneous brain activity at rest. Three background publications: - Pezzulo, G., Kemere, C., van der Meer, M. (2017) Internally generated hippocampal sequences as a vantage point to probe future-oriented cognition. Annals of the New York Academy of Sciences 1396, 144-165 - Pezzulo G., Zorzi M., Corbetta M. (2021) The secret life of predictive brains: what's spontaneous activity for? Trends in Cognitive Sciences, 25(9), 730-743 - Parr T., Pezzulo G., Friston K. (2022) Active Inference: The Free Energy Principle in Mind, Brain, and Behavior. MIT Press.

VENERDI' 1 OTTOBRE 2021

KEYNOTE LECTURE 2

NEUROCOGNITIVE MECHANISMS OF EMBODIED SELFHOOD

Jakub Limanowski

Abstract

Many neuroscientists, psychologists, and philosophers believe that embodied selfhood, the experience of having a body and being in control of its actions, relies on some representation of the 'own' body in the brain. But maintaining an adaptive neuronal body representation is not easy: It has to be stable enough for self-identification and action planning, but it also has to be flexible enough to adapt to a constantly changing environment—and a constantly changing body. Recent work appealing to probabilistic Bayesian inference, particularly the predictive coding framework, has opened up a new perspective on the potential neurocognitive mechanisms underlying body representation. A key tenet of these proposals is that body representation in the brain can be described in terms of a hierarchical generative model, which infers the causes of (bodily) sensations; and which is itself constantly updated based on integrating information from all relevant sensory modalities. In this talk, I shall link this idea to empirical work from my own lab and others, focusing on the respective information processing in the brain. Specifically, I shall discuss how this recent work supports a potential mechanistic perspective on bodily self-identification and self-other distinction in the passive state and in action; as based on said hierarchical model in the brain. This will show that body representation is truly flexible and, to some degree, can be shaped depending on attentional sets

or task demands. I shall conclude how such a mechanistic view may deepen our understanding of embodied selfhood, and how it may help to tackle challenges to embodied selves that arise through technological developments such as cyber-physical interactions.

SABATO 2 OTTOBRE 2021

KEYNOTE LECTURE 3

INVESTIGATING ABSTRACT AND CONCRETE WORDS IN THE BRAIN

Costanza Papagno

Abstract

Several studies have demonstrated the so-called “concreteness effect”—that is, the superior processing of concrete versus abstract words. This effect has been explained in quantitative terms: concrete concepts have both a verbal and a nonverbal representation, while this is not the case for abstract concepts. However, neuropsychological patients have been described with a reversal of concreteness effect, namely a better performance with abstract than concrete words, challenging that hypothesis. Available data suggest that the most frequent causes of this reversed effect are herpes simplex encephalitis and semantic dementia, which typically affect bilaterally anterior temporal regions, often in an asymmetrical way with a more severe damage to the left side, while abstract concepts are specifically impaired with damage to the inferior frontal gyrus (IFG). TMS studies and direct electrical simulation (DES) studies support the role of the IGF in processing abstract words; DES also supports the role of the left temporal pole in processing abstract concepts. The neuroimaging literature is more controversial as far as the role of the temporal lobe is concerned and do not match clinical evidence, but data confirm that concrete and abstract words involve at least partially segregated brain areas, the IFG being relevant for abstract nouns and verbs.

GIOVEDI’ 30 SETTEMBRE 2021

SIMPOSIO

BODILY SELF-PERCEPTION IN HEALTHY AND PATHOLOGICAL CONDITIONS

How the central processing of sensory information shapes bodily self-perception

Angela Marotta

Abstract

Voluntary movements are accompanied by the experience of controlling one's own movements (sense of agency) and the feeling that the moving body part belongs to one's self (sense of body ownership) [1]. Here we describe the results of two recent studies investigating how central processing of sensory information during bodily movements shapes agency and body ownership in healthy and pathological conditions. The first study [2] focused on the role of two multisensory brain regions, that is the premotor cortex (PMc) and the cerebellum, in subjective and proprioceptive components of agency and body ownership during voluntary actions. We exploited the moving RHI (mRHI) paradigm in which sensation of agency and/or body ownership are referred to a rubber hand. Using tDCS prior to the mRHI task, we found a specific causal contribution of the PMc and the cerebellum to bodily self-perception during voluntary movement, with the PMc mainly involved in awareness of action and the cerebellum in proprioceptive adaptation of body position in space. The second study [3] focused on the role of proprioception in the sense of agency. We tackled this issue by investigating possible alteration of the central processing of proprioceptive information in functional movement disorders (FMD), a pathological condition characterized by abnormal

sense of agency. To this aim, we used a position matching task in which transcutaneous vibration of the biceps brachii tendon of the arm elicited elbow flexion (tonic vibration reflex, TVR). Blindfolded participants had to match the final position of the vibrated arm with their contralateral tracking arm. The magnitude of the TVR of the vibrated arm and movement perception of the TVR of the tracking arm were significantly reduced in the patients compared to the controls. These results suggested that central processing of proprioceptive information is abnormal in patients with FMD. Proprioceptive dysfunction may underlie alterations in body movement and in sense of agency in such patients and may play a role in the pathophysiology of the disease. Through different approaches, these two studies contribute to understanding how central processing of sensory information shape bodily self-perception by providing new evidence on multimodal integration processes involved in movement control and action awareness in healthy and pathological conditions. References: 1. Gallagher I (2000). Philosophical conceptions of the self: Implications for cognitive science. Trends in cognitive sciences, 4, 14-21. 2. Marotta A, Re A, Zampini M, Fiorio M (2021). Bodily self-perception during voluntary actions: The causal contribution of premotor cortex and cerebellum. Cortex, 142, 1–14. 3. Tinazzi M, Marotta A, Zenorini M, Riello M, Antonini A, Fiorio M (2021). Movement perception of the tonic vibration reflex is abnormal in functional limb weakness. Parkinsonism & related disorders, 87, 1–6.

How the effects of actions become our own: the sense of agency and its neural correlates in healthy and pathological populations

Laura Zapparoli

Abstract

Although much of the functioning of our motor system occurs without awareness, we "know" when we are actors of our behavior. The feeling of voluntarily controlling our own actions and, through them, the events in the outside world, is the so-called sense of agency, a crucial component of action monitoring and self-awareness. To some, this sense of agency derives from a post-hoc reconstruction of a likely causal relationship between an event and our preceding movements (reconstructive hypothesis); others propose that the sense of agency originates from prospective comparisons of motor programs and their effects (constructive hypothesis). To test these alternative models, we devised a temporal judgment task that allowed us to measure the intentional binding phenomenon, an implicit measure of the sense of agency, in both healthy and pathological populations. Using fMRI, we found that in healthy subjects the sense of agency is associated with a brain network, including the pre-SMA and dorsal parietal cortex. Repetitive transcranial magnetic stimulation affected the sense of agency only when delivered over the pre-SMA, and specifically when time-locked to action planning, rather than when the physical consequences of the actions appeared. Our findings show that the activity of brain regions involved in action at the stage of its planning is important for the manifestation of an implicit sense of agency. These findings, together with data collected in pathological populations affected by movement disorders, make the constructive hypothesis of the sense of agency more likely and complete the circle of a conceptual validation of the implicit sense of agency as a phenomenon anchored to the functioning of the motor system.

Does the belief of owing a body gate tactile awareness?

Carlotta Fossataro

Abstract

The sense of touch contributes to discriminate one’s own from others’ bodies since the skin forms the boundary between self and non-self. Yet, it is unclear whether the sense of body ownership (the feeling that body parts actually belong to me) affects tactile awareness (the conscious experience of tactile events occurring on my body). Neuropsychological evidence supports the role of body ownership in shaping tactile awareness. Indeed, brain-damaged patients affected by Pathological Embodiment misattribute someone else’s hand to their own body and firmly report feeling tactile sensations on it whenever they see it being touched. This suggests that the belief of owning a body can induce a tactile experience on it, also revealing

that the brain is endowed with the inner potentiality of sensing a visual touch. The somatosensory system is able to discriminate tactile events occurring on one's own body (self-touches) from those occurring on others' bodies (other-touches). While the beta-band connectivity is generated both by self- and other-touches, the alpha-band connectivity, indexing aware tactile processing, pertains only to tactile events occurring on one's own body. Against this background, to investigate whether the belief of owning a body gates tactile awareness and modulates its electrophysiological correlates, we exploited the Rubber Hand Illusion (RHI). During the RHI, the synchronous stroking of the participants' concealed hand and a visible rubber hand induces a visuo-tactile conflict leading participants to feel as if the rubber hand were part of their own body. In experiment 1, participants' tactile perception ratings of touches delivered to either their own hand or the rubber hand were collected, both in the synchronous condition wherein the RHI emerges and in the asynchronous control condition wherein the RHI does not emerge. In experiment 2, TMS-EEG was applied over S1 to investigate the body ownership-dependent modulation of the alpha-band connectivity network generated by touches delivered to either the participants' or the rubber hand. Other-touches induced higher tactile perception ratings in synchronous compared to asynchronous condition, while self-touches induced lower tactile perception ratings in synchronous than in asynchronous condition. Crucially, the connectivity network fully paralleled the behavioral results, showing an increased alpha connectivity for other-touches and concurrently a reduced alpha connectivity for self-touches when the fake hand is embodied. Taken together these findings provide evidence for a top-down body ownership-dependent modulation of tactile awareness, supporting the view that '*I feel a body perceiving tactile sensation because I believe it to be mine*'.

SIMPOSIO

EVENT RELATED POTENTIALS (ERPS) IN NEURODEVELOPMENTAL DISORDERS: POTENTIAL BIOMARKERS?

High Intellectual Potential (HIP) and Autism Spectrum Disorder (ASD): two sides of the same coin? ERPs as possible indexes of different neurofisiological pattern

Luigi Mazzone

Abstract

It is well known that individuals with High Intellectula Potential (HIP) frequentely present associated neuropsychiatric conditions, such as specific learning disorders (DSA), anxiety disorders (general, social, obsessive-compulsive), attention deficit and/or hyperactivity (ADHD), dyspraxia, and Autism Spectrum Disorder (ASD). Specifically, it is ascertained that HIP and autistic individuals, particularly reffered to those recognized as High Functioning Autism (HFA), share common features in terms of clinical symptoms and neurobiological pathways. Thus, aim of the present disucssion is to briefly show results emerged from a study on the topic (unpublished). Particulalrly, the study was aimed to evaluate clinical and neurophysiological features - particularly referred to mismatch negativity (MMN) indexes - in a sample of HIP children in comparison to those with HFA and to neurotypical peers.

Autism and Attenuated Psychosis Syndrome (APS): neuropsychological profile and ERPs in a pediatric sample

Assia Riccioni

Abstract

By the last decade many studies have examined and demonstrated an association between Schizophrenia Spectrum Disorders (SSD) and Autism Spectrum Disorder (ASD), describing evidence for shared genetic, clinical, epidemiological and neurobiological features. Nevertheless, there are evidences such as the high prevalence of SSDs in ASD and of autistic symptoms in first episode psychosis patients or with Attenuated Psychosis Syndrome (APS). Despite these evidences, research in pediatric populations evaluating the

association between an UHR condition in ASD population is scarce. Aim of the present lecture is to exhibit clinical and neurophysiological features, with particular focus on mismatch negativity (MMN) indexes, in a pediatric sample of ASD participants (age range 9-18 years) with attenuated psychosis syndrome (ASD+APS) in comparison to ASD patients without APS (ASD-APS) and to healthy control (HC) groups.

Event Related Potentials as possibile biomarker of ADHD symptoms severity in Tuberous Sclerosis complex (TSC)

Stefano Pro

Abstract

Background and Aim: Tuberous sclerosis complex (TSC) is associated with a high rate of attention deficit-hyperactivity disorder (ADHD), usually with more severe symptoms than in idiopathic cases. Event-related potentials have been used in idiopathic ADHD, and they have been proposed as a possible biomarker of symptoms severity. Aim of this study was to investigate event-related potential (ERP) characteristics in patients with ADHD secondary to TSC, compared to patients with drug-naive idiopathic ADHD and healthy controls (HCs), to investigate whether (1) distinct clinical features can be due to different pathophysiological mechanisms, and (2) ERPs may reliably predict ADHD symptoms severity in TSC. Materials and Methods: We enrolled 13 patients with idiopathic ADHD (iADHD), 6 patients with ADHD associated with TSC (tscADHD), and 14 age-matched HCs (7-17 years). All of them underwent ERP recording, with mismatch negativity (MMN) preceding the P300 recording. All patients underwent neurocognitive evaluations. Results: Mismatch negativity latency was shorter in iADHD ($P = 0.04$) and tscADHD ($P = 0.06$) than in HC, with no difference between patients' groups. Mismatch negativity amplitude was significantly higher in patients (both iADHD and tscADHD) than in HC. The P300 amplitude was significantly lower in iADHD patients than in both tscADHD patients ($P = 0.03$) and HCs ($P < 0.001$). No difference was found between tscADHD patients and HCs ($P = 0.2$). Conclusion: While patients with iADHD present lower P300 amplitude than HC, in tscADHD patients P300 amplitude was not different from that in HC, suggesting that in TSC P300 amplitude does not really reflect symptom severity.

SIMPOSIO

THE CONTRIBUTION OF NEUROPHYSIOLOGY TO MIGRAINE: FROM BASIC MECHANISMS TO THE EFFECTS OF NOVEL TREATMENTS

Abnormal cross modal perception and cortical excitability

Filippo Brighina

Abstract

Background, objective: Sound-induced-flash-illusions(SIFI) are cross-modal audio-visual illusions: when a single flash is presented with two or more beeps, it is often perceived as multiple flashes (fission illusion); such illusions depend critically upon visual cortical excitability: increasing excitability reduces illusions. We previously showed that SIFI represent a reliable marker for visual hyperexcitability (less illusions) in episodic and chronic migraine with direct correlation with disease severity (1-2). Here we show data of more recent studies where SIFI were used to investigate other critical issues of migraine pathophysiology: changes of excitability underlying attack precipitation (study 1) and the relationship between peripheral and central mechanisms (trigemino-vascular system and cerebral modulation) as explored in patients treated with anti-CGRP monoclonal antibodies, known to exert its effects on peripheral target (study 2). Subjects and methods: For study 1 we examined 108 patients affected by episodic migraine without aura (mean age 38; 60 females) and 24 healthy controls (HC). Patients were studied across migraine phases: interictal (20 pts) preictal (20 pts), postictal (24 pts), ictal (20 pts). For study 2: 66 chronic migraine(CM) patients without aura (mean age 51 yrs +1.8; 44 F), treated for six month with anti-CGRP MAB and 30 HCs subjects (25 females) in the same age range. All subjects underwent SIFI examination. HCs were examined

once while CM patients performed the test at the beginning(t0) and after 3 and 6 months of treatment (t3, t6). SIFI were explored presenting flashes and beeps in different arrangements. Subjects had to count flashes seen. ANOVA with Duncan's post-hoc analysis was used for comparisons. Results: Results of the study 1 showed significant decrease of the number of fission illusions during the preictal phase compared to the interictal one ($p<.03$) and during the postictal phase compared to the interictal one($p<.01$). CM reported less flashes than HCs at t0, t3($p< 0.001$) and t6($p<0.05$). Patients intragroup comparisons, showed significant increase in flash percepetion between t0 and t6($p<0.05$) and no change at t3 even if a significant increase of 1F4B scores was found at planned comparisons at T3 too($p<0.05$). Discussione e conclusioni: SIFI are reliable and effective measure of visual cortical excitability in migraine. According to SIFI results, hyperexcitability seems to play a relevant role in migraine pathophysiology. Excitability changes underlie mechanism of attack precipitation and are linked also with disease severity. Higher excitability levels are found in high frequency and chronic migraine; excitability decreases following effective treatment even with drugs targeting peripheral target as anti-CGRP antibodies. References: 1. Brighina F, Bolognini N, Cosentino G, et al. Visual cortex hyperexcitability in migraine in response to sound-induced flash illusions. Neurology. 2015;84(20):2057-61 2. Maccora S, Bolognini N, Cosentino G, et al. Multisensorial Perception in Chronic Migraine and the Role of Medication Overuse. J Pain. 2020;21(7-8):919-929.

Peripheral interference by CGRP inhibition on basic cortical dysfunction

Marina de Tommaso

Abstract

Migraine in a disabling disorder of neuro-vascular origin. Neuronal dysfunction predisposes to attacks onset, with secondary involvement of the vascular system. The cortical excitability of the migraine brain is different from the not migraine one, with a critical unbalance between excitatory and inhibitory neurotransmission. The complex interictal dysfunction of migraine brain could be the main cause of Cortical Spreading Depression (CSD), a bioelectrical phenomenon followed in a causal mode by the activation of the trigemino-vascular system, with antidromic recruitment of meningeal vessels, vassal dilation and inflammatory neurotransmitters extravasation. A new era in migraine treatment occurred since the introduction of Calcitonin Gene Related Peptide –CGRP-monoclonal antibodies. The antagonistic action on CGRP is thus a mode to cause an interruption of headache generation via a peripheral inhibition of the nociceptive system. Understanding the theoretic basis of peripheral interaction via CGRP inhibition on the complex central dysfunction subtending migraine, could help in figure out how peripheral modulation could change neuronal central excitability and connectivity. A very recent study reported that a single dose 70 mg of enerumab caused a relevant change of functional connectivity from the hypothalamus to the insula, temporal lobe, hippocampus and trigeminal nuclei. [Ziegler et al, 2020]. Growing evidence are supporting how peripheral nerves involvement at somatic and trigeminal level, could change brain functional connectivity, specially within the network devoted to pain processing. Mathematical models of CSD on realistic MRI from migraine with aura patients showed that the propagation of hyperpolarization phenomenon could in theory involve cortical areas in the network of pain processing [Kroos et al, 2019]. The tonic inhibition of trigeminal peripheral afferents inputs to the cortex, exerted by CGRP monoclonal antibodies, could thus modulate the excitability of the large network dedicated to nociceptive signals elaboration [de Tommaso et al, 2021], also changing the mode of cortical connections favoring the generation and extension of critical bioelectrical phenomena. Future long term efficacy studies on CGRP-mAbs, coupled with neurophysiological evidence of possible interference on brain connectivity features, could possibly confirm the impression that a specific and prolonged action on the trigemino-vascular system, though limited to the periphery, has a pivotal role in migraine puzzle resolving. Ziegeler C, Mehnert J, Asmussen K, May A. Central effects of erenumab in migraine patients: An event-related functional imaging study. Neurology. 2020 17;95(20) de Tommaso M, Delussi M, Gentile E, Ricci K, Quitadamo SG, Libro G. Effect of single dose Erenumab on cortical responses evoked by cutaneous a-delta fibers: A pilot study in migraine patients. Cephalalgia. 2021; 41(9):1004-1014. Kroos JM, de Tommaso M, Stramaglia S,

Vecchio E, Burdi N, Gerardo-Giorda L. Clinical correlates of mathematical modeling of cortical spreading depression: Single-cases study. Brain Behav. 2019 Oct;9(10).

Monoclonal antibodies against the CGRP receptor exert a differential effect at the level of the caudal trigeminal nucleus and at the level of the somatosensory cortex in migraine patients

Gianluca Coppola

Abstract

Objectives: Subcutaneous injection of monoclonal antibody against CGRP receptor erenumab has been approved for the prophylactic treatment of migraine. Although different studies have shown that this treatment is highly effective and safe, the neurophysiological mechanisms underlying its clinical efficacy are still debated widely. In particular, it is not yet clear whether the neurophysiological effects of the drug are exclusively confined to the periphery of the trigeminal system or also occur centrally, at the cortical level. This study assessed the neurophysiological effects of erenumab injection in a group of patients with migraine unresponsive to at least 2 prophylactic treatments. Methods: We prospectively enrolled 20 migraine patients (15 with chronic migraine and 5 with high-frequency episodic migraine). In all participants, we recorded the blink reflex (nBR), after stimulation of the right supraorbital nerve with a nociception specific concentric electrode, and the non-noxious somatosensory evoked potentials (SSEPs) after repetitive electrical stimulation of the median nerve at the wrist. We measured nBR R2 area-under-the-curve (AUC) and habituation, and SSEP N20-P25 amplitude and habituation. Neurophysiological measurements were recorded before and at month-1 (T1) and month-2 (T2) before each monthly erenumab injection.
Results: At T2, erenumab significantly reduced the mean monthly headache days, severity of headache (0-10), and the mean monthly tablet intake (all p=<0.001). Compared to baseline, the nBR AUC was significantly reduced at T1, but not at T2, without changing the habituation slope. A significant increase in delayed SSEP amplitude decrement (habituation), but not in the initial cortical activation, was noted at T1 and, more so, at T2 after the beginning of the treatment compared to the baseline (slope baseline = +0.103, T1 = -0.167, T2 = -0.229, p <0.05). Conclusion: The results of our study show for the first time that the clinical improvement induced by Erenumab can be attributed to neurophysiological changes occurring at both the brainstem and cortical levels.

Can clinical neurophysiology find the pathophysiological signature of migraine in children?

Massimiliano Valeriani

Abstract

Neurophysiologic techniques have proved very useful in studying migraine patients. The main contribution of clinical neurophysiology regards the pathophysiological investigation of primary headaches. The primary headache phenotype is the result of the contribution of both genetic and environmental factors, the first being prevalent in childhood. Seen from this light, it is surprising that neurophysiologic investigation has been far more often addressed to the young adulthood, while children have been rarely studied. Neurophysiologic studies in children and adolescents, beyond highlighting some peculiarities that primary headaches show in this population, can approach the pathophysiological mechanisms of the disease. Indeed, in the early part of life the confounding influence of the environmental factors is far lower than in adults. Studies have used multimodal evoked potentials to investigate the excitability of the cerebral cortex in children with migraine. Event related potentials (ERPs) have been correlated with neuropsychological tests to investigate the pathophysiology of cognitive disturbances in these patients. They have been also correlated with the psychological symptoms. Basically, findings issued from short-latency EP recordings demonstrated a reduced inhibition of the cerebral cortex in young patients with migraine. ERP studies succeeded in correlating the cerebral cortex dysexcitability with psychological symptoms, thus suggesting a deep interaction between the genetic background of migraine and the individual psychological profile. In

conclusion, neurophysiologic studies in children and adolescents with primary headaches provided original and useful information about the pathophysiological mechanisms subtending these diseases. Moreover, they showed that, at this age, strict interaction between genetic background and psychological elements is fundamental to determine the clinical phenotype.

SIMPOSIO

CEREBELLAR ROLE IN SEMANTIC MEMORY, SOCIAL COGNITION, PAIN CONTROL AND HYPNOTIZABILITY

Cerebellar involvement in semantic memory: evidence from brain stimulation

Daniele Gatti

Abstract

Traditionally, the cerebellum has been linked to motor functions, but recent evidence suggest that it is also involved in a wide range of cognitive processes. Given the uniformity of cerebellar cortex microstructure, it has been proposed that the same computational process might underlie cerebellar involvement in both motor and cognitive functions. Within motor functions, the cerebellum it is involved in procedural memory and associative learning. Here, we hypothesized that the cerebellum may participate to semantic memory as well. To test whether the cerebellum is causally involved in semantic memory, we carried out three experiments administering online transcranial magnetic stimulation (TMS) over the right cerebellum or over a control site. In the first two experiments participants performed the Deese-Roediger-McDermott paradigm (DRM) and in the third participants judged whether noun-adjective word-pairs were semantically related (e.g., red apple) or not (e.g., blue banana). In Experiment 1, cerebellar TMS selectively affected participants' discriminability for critical lures without affecting participants' discriminability for unrelated words and in Experiment 2 we found that the higher was the semantic association between new and studied words, the higher was the memory impairment caused by the TMS. In Experiment 3, when TMS was administered over the right cerebellum, participants' performance was less influenced by the relatedness between the two words. These results indicate that the right cerebellum is causally involved in semantic memory and provide evidence consistent with theories that proposed the existence of a unified cerebellar function within motor and cognitive domains, as well with recent perspectives about cerebellar involvement in semantic memory and predictive functions.

How social is the cerebellum? Neuropsychological and neurostimulation findings

Cosimo Urgesi

Abstract

The Cerebellar Cognitive Affective Syndrome entails important deficits in social behavior and in social cognitive processing that may be accounted for by impairments of the predictive function exerted by the cerebellum. It is unclear, however, whether this prediction function is specific for the social domain or reflects a domain-general predictive role of cerebro-cerebellar networks. To address this issue, we used an implicit learning paradigm to explore the use of contextual information to predict the outcome of social (i.e., action unfolding) or physical (i.e., the appearance of geometrical shapes) events. This paradigm was used both with patients with congenital, non-progressive cerebellar malformations and with healthy individuals receiving tDCS over the posterior cerebellum. Results indicated that children and adolescents with congenital, non-progressive cerebellar malformation showed a domain-general deficit in using contextual information to predict both others' movements and physical events, and that this impairment was independent from patients' cognitive abilities. However, the social prediction deficits showed specific correlations with social cognition impairments at standard neuropsychological testing, pointing to their clinical relevance. Furthermore, tDCS of the posterior cerebellum only affected performance at the social prediction task, suggesting that different cortico-cerebellar networks may subserve prediction in social and

non-social domains. Based on these results, we developed a VR training to improve predictive abilities in a social scenario (VR-SPIRIT). In a randomized, single-blind controlled clinical trial, the performance of patients with non-progressive cerebellar malformation in the VR scenario, at the action prediction task and at standard neuropsychological tests was compared before and after the VR-SPIRIT or a control, VR-based motor training. Patients allocated to the VR-SPIRIT training not only increased the use of predictive strategies in the VR application, but also showed a stronger reliance on context-based predictions in the action prediction task as compared to those allocated to the control training. Crucially, both groups significantly enhanced the performance at tests of visual attention, executive functions, and visuo-spatial processing, but only VR-SPIRIT patients showed significant improvements at tests of theory of mind and emotion recognition. These findings shed new light on the predictive role of the cerebellum and its contribution to social cognition, paving the way for new approaches to the rehabilitation of the Cerebellar Cognitive Affective Syndrome.

The "painful" cerebellum: new evidence for an old debate

Tommaso Bocci

Abstract

Objective: the cerebellum is engaged in a wide range of motor and non-motor functions, comprising motor learning and working memory, but its role in the nociceptive processing has been only recently recognized. Converging evidence in the literature suggests a key cerebellar involvement not only in the sensory-discriminative, but also in the affective-emotional and cognitive dimension of pain. Because of its anatomical position, strategically located between the brainstem and the cortico-subcortical "pain matrix", the cerebellum is able to interfere both with top-down and bottom-up mechanisms underlying pain perception and motor withdrawal. Materials and Methods: an increasing number of studies have recently explored the possibility to modulate the nociceptive processing by non-invasive brain stimulation (NIBS) techniques applied over the cerebellum in patients with chronic pain syndromes; that is of critical importance to simultaneously interfere with spinal and supra-spinal dysfunctional pathways involved in the central sensitization of pain. We encompass the current literature supporting the cerebellar role in nociceptive processing and possible therapeutic applications. Results: converging evidence strongly supports the hypothesis of a "painful" cerebellum and a growing body of the literature suggests the use of NIBS techniques to modulate both ascending and descending nociceptive pathways in chronic pain syndromes, such as phantom limb pain (PLP), with clinical effects lasting for weeks after protocol completion. Discussion: future studies will explore the possibility to combine different targets of tDCS action, as well as the opportunity to deeply stimulate brain targets with novel non-invasive devices. References: Bocci T, De Carolis G, Ferrucci R, Paroli M, Mansani F, Priori A, Valeriani M, Sartucci F. Cerebellar Transcranial Direct Current Stimulation (ctDCS) Ameliorates Phantom Limb Pain and Non-painful Phantom Limb Sensations. Cerebellum. 2019;18(3):527-535. Bocci T, Santarcangelo E, Vannini B, Torzini A, Carli G, Ferrucci R, Priori A, Valeriani M, Sartucci F. Cerebellar direct current stimulation modulates pain perception in humans. Restor Neurol Neurosci. 2015;33(5):597-609. Guidetti M, Ferrucci R, Vergari M, Aglieco G, Naci A, Versace S, Pacheco-Barrios K, Giannoni-Luza S, Barbieri S, Priori A, Bocci T. Effects of tsDCS in patients with chronic pain: a clinical and neurophysiological study. Front Neurol. 2021; in press.

Hypnotizability and the cerebellum: facts and hypotheses

Enrica L. Santarcangelo

Abstract

Hypnotisability is a multidimensional trait predicting the proneness to enter hypnosis and/or accept suggestions. It is measured by scales and is associated with several psychophysiological correlates which are observable also in the ordinary state of consciousness and in the absence of suggestions. Most studies have investigated the morpho-functional characteristics of the executive, salience and default mode circuits disregarding the possible role of other structures in hypnotic phenomenology (Landry et al., 2017). The

earliest observation of the role of cerebellar characteristics in a few hypnotizability-related characteristics raised from findings regarding sensorimotor integration (Santarcangelo and Manzoni, 2021). Looser postural and visuomotor control with no learning across trials in fact, can be accounted for by a less accurate cerebellar predictive model of information processing, together with greater attentional stability. Structural magnetic resonance revealed reduced grey matter volume in the left cerebellar lobules IV-VI (Picerni et al., 2019), which might be involved in the highs' greater excitability of the right motor cortex observed in resting conditions and during motor imagery with respect to lows. Such greater excitability may be involved in the highs' a) stronger functional equivalence between imagery and perception/action, b) greater proneness to ideomotor behavior following sensorimotor suggestions, c) experience of involuntariness and effortlessness of the suggested actions. Moreover, d) the highs' paradoxical pain control after cerebellar anodal stimulation may depend on reduced cortical inhibition of the pain matrix by the cerebellum. Finally, peculiar cerebellar function may account for the highs' greater attentional stability, higher blink rate and interoceptive sensitivity. Further research is needed, however, to ascertain whether the cerebellum is the sole responsible for the observed, non-motor hypnotizability-related differences. Work in progress will ascertain whether the brain availability of endothelial nitric oxide (NO) is larger in highs than in lows, as occurs for the brachial artery during mental stress and nociceptive stimulation. In physiological conditions, in fact, NO exerts a positive influence on the brain development, maturation and plasticity, whereas excessive/uncontrolled NO availability could impair the maturation of the nervous tissue and particularly of granule cells and be involved in the highs' cerebellar (and cerebral) morpho-functional characteristics. References: Landry, M., Lifshitz, M., & Raz, A. (2017). Brain correlates of hypnosis: A systematic review and meta-analytic exploration. Neuroscience & Biobehavioral Reviews, 81, 75-98. doi.org/10.1016/j.neubiorev.2017.02.020 Picerni, E., Santarcangelo, E.L., Laricchiuta, D., Cutuli, D., Petrosini, L., Spalletta, G., & Piras, F. (2019). Cerebellar Structural Variations in Subjects with Different Hypnotizability. Cerebellum. 18(1),109-118. doi: 10.1007/s12311-018-0965-y. Santarcangelo EL, Manzoni D. Hypnotizability and the cerebellum: hypotheses and perspectives. Cerebellum, in press 2021.

SIMPOSIO
OLFACTORY FUNCTIONS IN AGING AND CLINICAL DISEASES

Human aging arise trough olfactory sensitivity
Andrea Mazzatenta

Abstract

The sense of smell is a chemosensory processing that can detect potentially infinite numbers of low molecular-mass compounds and it is devoted to the capture of the infinite molecular diversity of the environment, to extract vital information through the generation of individual perceptions that relate to food, surroundings and relationships. Consequently, functional impairment of olfaction has a negative impact on quality of life. The question about subjective capabilities is still open. In addressing these question: i. the lower limit of human olfactory discrimination has been increased to more than one 'trillion' odors; ii. individual olfactory fingerprint has been clarified, and this relates to the expression of a unique subset of the repertoire of olfactory receptors. Despite these breakthroughs, how olfaction fluctuates over time remains largely unanswered, and in particular, the process of natural aging of olfaction and its decline in the absence of any overt disease conditions. To define this process of natural aging and the decline of olfaction, we measured one of the olfactory functional parameters, olfactory threshold, across the full spectrum from children to the elderly. Six hundred and twenty-two healthy individuals were enrolled, as representative of the Italian geographical spread: 256 males (mean age, 30.67 years ±18.3 SD; interquartile range [Q3-Q1], 25 years; age range, 5-88 years) and 366 females (mean age, 28.95 years ±16.24 SD; interquartile range [Q3-Q1], 14 years; age range, 5-105 years). The experiments were performed under standardized conditions in a well-aired/ odorless room, without any bias. The olfactory stimulation was the

widest used in similar studies, as n-butanol and its dilutions. Testing method used was a modified Cain test. The volatilized n-butanol stimulus was measured in the real-time setting using an e-nose sensor. To validate the testing processes and the absolute olfactory threshold test itself, the reliability was calculated. The threshold was measured here by olfactory testing on a healthy population (n = 622; age range, 5-105 years). We also reduced the chemo-physical variability by using an electronic nose device (e-nose) to measure the differences (Δ) between the measured quantitative curves of the volatilized reference material and the respective stimulation solutions in real time. Discussione: This analysis shows that age-related variations in the absolute olfactory threshold are not continuous; instead, there are multiple olfactory phenotypes, a situation that has not been described previously. These data thus define three distinct age-related phenotypes, which we have termed the 'juvenile', 'mature' and 'elder' olfactory phenotypes. Mazzatenta A et al. Olfactory phenotypic expression unveils human aging. Oncotarget. 2016; 7: 19193-19200. Retrieved from https://www.oncotarget.com/article/8393/

Olfactory function, eating behavior and lifestyle in elderly subjects

Giorgia Sollai

Abstract

The sense of smell plays an important role in the identification of environmental dangers, in social relationships, in eating behavior and in food choices. In addition to neurodegenerative, inflammatory/immune, metabolic, depressive and nasal diseases, the olfactory function is mainly affected by the natural aging process. Olfactory dysfunction significantly affects nutritional status, quality of life, physical well-being, daily safety and mortality. Physical activity is known to positively affect many risk factors for cardiovascular and neurodegenerative diseases, diabetes, obesity, mental health, etc…. The benefits of exercise are particularly evident in older populations, where they have been associated with maintaining good physical and mental health and increasing lifespan. We evaluated the impact of active or non-active lifestyle in terms of physical, cognitive and social activity on the olfactory function in Elderly Subjects (ES) and on their BMI, also according to their olfactory status; we looked for a correlation between the time devoted to life activities and the olfactory score obtained by each individual and the BMI presented by each of them.

Elderly volunteers were recruited in Sardinia (Italy) and were divided in active ES (n = 60; age 67.8 ± 1.12 y) and inactive ES (n = 62; age 71.1 ± 1.14 y) based on their daily physical activities, assessed by means of personal interviews. The overall olfactory function and the individual ability to perceive, discriminate and identify odors were evaluated using the "*Sniffin's Sticks*" battery test. A significant effect of active or inactive lifestyle was found on the olfactory function of ES ($F_{1,120} > 10.16$; $p < 0.005$) and on their BMI ($F_{1,120} = 48.19$; $p < 0.0001$). Inactive ES showed a BMI significantly higher than active ES in both normosmic ($p < 0.005$) and hyposmic individuals ($p < 0.02$). In both active and inactive ES we found: a) a positive correlation between the olfactory scores and the number of hours per week dedicated to physical activities (Pearson's $r > 0.32$, $p \leq 0.014$); b) a negative correlation between BMI and the olfactory scores (Pearson's $r > -0.33$, $p < 0.01$) and between BMI and the number of hours dedicated to physical activities (Pearson's $r > -0.37$, $p < 0.005$). These results highlight a strong association in the elderly between olfactory function and lifestyle, between olfactory function and BMI, and BMI and exercise and non-exercise physical activity levels. The elderlies often have limitations in their movements and therefore in the possibility of carrying out exercise physical activity, so they could benefit from the increase of non-exercise activities to improve not only their olfactory function, but also their quality of life.

Olfactory alteration after SARS-CoV-2 infection. The clinical experience

Giacomo Spinato

Abstract

Manca

Stress, Hyposmia, Anosmia, Normosmia and Augesia after SARS-CoV-2 infection
Sara Invitto

Abstract

SARS-Co-V-2 related symptoms related to anosmia and ageusia are known, and can persist in the medium and long term. Furthermore, literature results indicate that the chemosensory symptoms of SARS-Co-V-2 can predict neurological comorbidities. There are no studies that highlight correlations between sensory and cortical aspects, in particular associating them with stressful and emotional aspects. The present study consisted in two level of investigation. The first step was conducted on a sample of 205 adult patients (mean age 40 years, 165 Women) with previous SARS-Co-V-2 infection. SARS-Co-V-2 Patient Sample showed different symptomatology: 10% was asymptomatic; 79% has had mild flu symptoms; 6% has had severe flu symptoms; 5% had resorted to the forced administration of oxygen. 90% of the SARS-Co-V-2 sample, who had not had flu symptoms, but who tested positive for the swab, presented changes in odor. During the post-SARS-Co-V-2 infection, 42% of the patients were anosmic, 56% presented hyposmia and 2% hyperosmia; about the gustatory function the 36% had normogeusia, 60% ageusia and 4% hypergeusia. Both olfactory and gustatory functions were investigated through an adaptation of the Sniffing Sticks Smell Test (SSST) (modified for an online survey), the Perceived Stress Scale and the Body Perception Questionnaire. The analysis of behavioral data revealed significant differences in the odor factor, intensity of perception and familiarity of the odor, level of anosmia and ageusia. The stress factor also affected the intensity of the symptoms, unlike the level of somatization which seems to have no impact on what was analyzed. The analysis also highlighted gender differences in the direction of greater anosmia / ageusic symptoms in women. The second step was conducted in the hospital, on a subsample of patients. We investigated the EEG rhythms elicited by the olfactory stimulation (the same smells of the SSST were administrated to the subjects). The electrophysiological results on alpha showed a significant difference for the Odor effect per group in the direction of lower alpha for Covid-19. The delta rhythm reveals an interaction linked odor *Group and electrodes position. Patients who have had SARS-Co-V-2 showed a frontal delta activity with the turpentine odorant (trigeminal) and a lower activation with the cinnamon odor (not trigeminal). As preliminary results we can conclude that there is a lower alpha activity in SARS-Co-V-2 patients, an equal response to trigeminal stimuli highlighted by the delta activity and a lower gamma activity, corresponding to a reduced perceptual olfactory response. Furthermore, the variation in both behavioral and electrophysiological perceptual responses is related to perceived stress during infection.

VENERDI' 1 OTTOBRE 2021

SIMPOSIO
DREAMING AS BRAIN-MIND CONNECTION

Sleep and memory
Raffaele Ferri

Abstract

For the correct formation of memory traces both an encoding or learning of information and a consolidation of the learned information in long-term memory are needed, as well as subsequent recall. It is now well known that sleep and memory consolidation are with a large amount of published evidence that sleep subserves the consolidation of learned information into long-term memory traces.[1] Two main different but non-exclusive comprehensive theoretical frameworks have been proposed for the relationship between sleep and memory consolidation. The "synaptic homeostasis" and the "synaptic strength" hypotheses involve that changes in the synaptic connectivity during learning might lead to an increasing

need of space and energy; downscaling synaptic strength would save energy and eliminate unnecessary information (noise) from the previous day. The resulting refreshed synaptic networks favor subsequent learning and memory; also supporting, at least in part, the well-known need to select information to retain and discard useless items, taking place during sleep.[2] The second theory starts from the observation that memory formation is dependent on different proportions of sleep stages. In the "dual process hypothesis" NREM-rich sleep during the first period of the night is considered to be beneficial for declarative memory, and REM-rich sleep of the last half of the night is considered to favor non-declarative, implicit or procedural memory, with a subsequent development of "sequential hypothesis" emphasizing the relevance of the succession of processes occurring during NREM sleep and REM sleep for memory consolidation.[3] All theories, even if supported by convincing evidence, are still far from having completely explained the complex relationship between sleep and memory and further research is needed. It is essential to investigate sleep and consolidation of memory and to search for a more comprehensive view encompassing systems and cellular levels, as well as global and local levels.

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Brain networks underlying dream activity

Giulio Bernardi

Abstract

Conscious experiences generated during sleep are thought to reflect and potentially have a role in the sleep-dependent processing of previously acquired memories. Moreover, they have a tight relationship with psychophysical health. Indeed, alterations in the frequency or content of oneiric experiences may accompany or even precede the waking manifestation of clinical symptoms related to neurological or psychiatric disorders. Importantly, dreams also constitute a fundamental model for investigating the neural bases of human consciousness due to their nature of phenomenological experiences spontaneously generated by the brain independently from sensory input, motor output, and volitional processes. Given these considerations, the study of dreams lies at the intersection between philosophical, psychological, neurophysiological, and clinical interests. Yet, our understanding of the origin and function(s) of dreams is still largely incomplete.

A growing body of evidence supports the existence of a relationship between EEG slow waves (<4 Hz) typical of non-REM sleep and the level of mental activity during sleep. Indeed, slow waves are generated when neurons become bistable and oscillate between silent OFF-periods of hyperpolarization and ON-periods of depolarization and intense firing. Crucially, the OFF-periods appear to disrupt causal interactions among neuronal populations, thereby impairing information integration, which has been proposed to represent a key prerequisite for the emergence of any conscious experiences. Yet, recent evidence made clear that having or not a conscious experience during sleep does not simply depend on how numerous (or large) slow waves are. Instead, where the slow waves occur also plays a crucial role. Indeed, recent work combining overnight hd-EEG recordings and a serial-awakenings experimental paradigm demonstrated that conscious experiences occurring during sleep are associated with a decrease in slow (sleep-like) and an increase in fast (wake-like) EEG activity, especially in posterior brain areas. Moreover, this and other studies showed that distinct types of mental activity (i.e., thought-like or perceptual) and distinct perceptual contents (e.g., faces, places, movement, or speech) are associated with the appearance (disappearance) of wake-like (sleep-like) activity in cortical brain regions closely corresponding to those recruited during similar experiences in wakefulness. Overall, these findings have profound implications, as they indicate that specific topographic changes in slow-wave activity correspond to predictable variations in the level and content of sleep mental activity. More in general, they also support a view of sleep and wakefulness as two

non-mutually exclusive states that may often co-exist in physiological conditions and whose respective balance is altered in pathological states.

EEG correlates of dream recall upon awakening from REM and NREM sleep

Luigi De Gennaro

Abstract

Background: Quantititive EEG analysis and laboratory awakenings are considered the gold standard method to investigate neurophysiological correlates dream recall. After awakenings from NREM sleep, some studies have found a relationship between alpha activity and dream recall, although the results are not always consistent. Also dream recall after REM sleep is associated to alpha and theta activity on the frontal regions (Marzano et al., 2011). Keeping in mind the role played by the theta and alpha rhythms in the episodic memory formation and retrieval (Klimesch, 2006), it may be hypothesized a sort of continuity between the mechanisms that modulate episodic memory processes across sleep and wakefulness. Aims: We will review some studies aimed to clarify two main questions: (1) defining the EEG correlates of dream recall; (2) if the frequency- and topographic-specific differences upon awakening from different sleep stages actually reflect stable inter-individual differences (i.e., trait-like) or specific activations associated to the interval just preceding awakening (i.e., state-like) Methods: All studies will share common procedures with full-scalp EEG recordings and collection of dream reports associated to specific electrophysiological patterns, the only notable differences concern (A) timing of awakenings (final or multiple intra-night); (B) design (between- or, within-subject design), or (C) sleep episode (whole night or diurnal nap). Results and Conclusions: Results are mostly coherent with the hypothesis of continuity between the mechanisms of wakefulness episodic memory and dream production. Not alternatively, in other studies we found an association with levels of EEG activation (i.e., more activated EEG pattern predict dream recall). The general pattern of results seems more coherent with the idea of state-like EEG differences. Two general questions still remain open: (1) Are electrophysiological patterns associated with dream recall different when comparing REM vs. NREM awakenings? (2) Is it possible to develop an original technique or protocol to directly access to dream generation (i.e., not limiting studies to dream recall upon awakenings)? References: Klimesch, W., Hanslmayr, S., Sauseng, P., Gruber, W., Brozinsky, C. J., Kroll, N. E. A., Yonelinas, A. P., and Doppelmayr, M. (2006). Oscillatory EEG correlates of episodic trace decay. Cereb. Cortex 16, 280–290. Marzano, C., Ferrara, M., Mauro, F., Moroni, F., Gorgoni, M., Tempesta, D., Cipolli, C., and De Gennaro, L. (2011). Recalling and forgetting dreams: theta and alpha oscillations during sleep predict subsequent dream recall. J. Neurosci. 31, 6674–6683.

SIMPOSIO

BEHAVIORAL PREDICTION, ATTENTIONAL FILTERING, COGNITIVE CONTROL: THE TOUGH WORK OF OUR BRAIN IN THE HUMAN-ENVIRONMENT INTERACTION

Implicit learning prevails over explicit learning during prediction of possible outcomes under perceptual uncertainty

Valentina Bianco

Abstract

Accurate prediction of the sensorial outcomes associated with social or physical events is a crucial aspect during everyday life. This ability relies on the implicit learning of the statistical regularities of past events in specific contexts in order to guess the most probable outcome. Previously, it has been shown that even a short-lasting experience of specific associations between a contextual cue and a social (e.g., action) or physical (e.g., shape) event biases predictions in conditions of perceptual uncertainty. In the present study, we challenged the relative contribution of implicit and explicit learning on the prediction of social and physical events. The former was implemented by manipulating the strength of association of possible action/shape scenarios with arbitrary contextual cues (high vs low contextual prior); the latter was implemented by manipulating the validity of a trial-by-trial performance feedback, which could be biased to

either the contextual prior or the sensory evidence. Overall, we found that providing a contextual feedback suddenly reinforced the prediction of actions/shapes embedded in high-prior contexts and worsened the prediction of those embedded in low-prior contexts. Conversely, providing a sensorial feedback had weaker and later effects, ultimately failing to override the reliance on contextual priors. Indeed, even a long-lasting explicit learning encouraging the processing of sensorial information was not powerful enough to prioritize sensorial evidence against the implicitly-learned contextual priors. These results suggest, in line with Bayesian accounts of perception, that prior expectations resulting from implicit learning guide the prediction of both social and physical events more than the explicit learning of sensorial discrimination.

Investigating the role of the dorsal fronto-parietal attention network in distractor filtering and in the attention-modulated surround suppression mechanisms by means of TMS

Carlotta Lega

Abstract

In our environment, there is an overabundance of available visual information. Visual selective attention endows individuals with the capacity to extract the relevant element for in-depth processing, while disregarding irrelevant and potentially distracting elements in the visual environment, thus optimizing perception and behavioral control. However, salient yet task-irrelevant distractors in the stimulus array can interfere with target selection. This is due to the unwanted shift of attention towards the salient stimulus, the so-called attentional capture effect, which delays deployment of attention onto the target. At the same time, converging evidence demonstrated greater levels of suppression for stimuli immediately surrounding an area of attention than for stimuli that are further away, therefore indicating that the effect of attention does not decrease with distance in a monotonic fashion. At the neural level, these mechanisms are thought to arise from top-down frontoparietal recurrent activity, which would modulate activations in early visual cortex. However, the respective roles of different nodes within the network and their hemispheric specialization are still under debate. In two different studies, we used transcranial magnetic stimulation (TMS) to evaluate the causal role of two key regions of the dorsal attention network in resisting attentional capture by a salient singleton distractor and in determining the center-surround profile of the attentional focus: the frontal eye field (FEF) and the cortex within the intraparietal sulcus (IPS). Results of study1 provide direct causal evidence that the right FEF houses key mechanisms for distractor filtering, pointing to a pivotal role of the frontal cortex of the right hemisphere in limiting interference from an irrelevant but attention-grabbing stimulus. Results of study 2 indicated that stimulation of both FEF and IPS of the right hemisphere significantly modulated the center surround profile, by widening the inhibitory ring around the attentional focus, thus providing the first causal evidence of the role of the dorsal frontoparietal network in determining the center-surround organization of the allocation of the attention. Together, the present findings give an important insight into the role of the frontoparietal network in orchestrating inhibitory spatial attentional mechanisms that are needed to select task-relevant information and to limit interference by salient and confusable surrounding representations.

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

Rinaldo Livio Perri

Abstract

Introduction: Compelling literature has suggested the possibility of adopting hypnotic suggestions to override the Stroop interference effect. However, most of these studies mainly reported behavioral data and were conducted on highly hypnotizable individuals. Thus, the question of the neural locus of the effects and their generalizability remains open. In the present study, we recorded the event-related potentials (ERPs) during the Stroop task to test the neurocognitive effects of two hypnotic suggestions: the perceptual request to focus only on the central letter of the words and the semantic request to observe meaningless symbols.

Methods: Seventeen healthy volunteers participated in the study. Participation in the experiment consisted of three sessions. In the first session, the individual level of hypnotic susceptibility was assessed through the Harvard scale (HGSHS-A); in the second and third sessions, EEG activity was recorded while subjects performed the Stroop task. The sample's hypnotizability score was 7.1, indicating moderate hypnotic susceptibility. In the EEG sessions, participants were asked to perform the Stroop task in both the control (C) and the hypnosis (H) conditions. In the latter, the perceptual or semantic suggestion was verbally administered after a formal hypnotic induction procedure. The order of the two suggestions, such as the order of conditions in each session (C-H, H-C), was counterbalanced across subjects. The EEG signal was recorded using 32 electrodes, and two different segmentations were adopted to look at the ERP activity in the prestimulus and the poststimulus stage of processing. As for the behavioral data, response times and percentage of errors were calculated for the Stroop task. Results: Behavioral results indicated that the two types of suggestions favored more accurate performance compared to the control condition. As for the ERP data, results indicated that both types of suggestions increased sensory awareness (anterior pN1 component) and reduced discriminative visual attention (posterior N1 component), while the perceptual request selectively engaged more executive control of the prefrontal cortex (increased amplitude of the pre-stimulus pN component), and the semantic request selectively suppressed the temporal cortex activity devoted to graphemic analysis of the words (the left P180 component). Discussion: the present findings demonstrated that the perceptual and the semantic hypnotic suggestions reduced Stroop errors through common and specific top-down modulations of different neurocognitive processes. Finally, as most of the present subjects expressed a medium level of hypnotizability, the present data might be considered potentially representative of the majority of the population.

SIMPOSIO

MULTI-FACETED SOCIAL COORDINATION: ATTUNEMENT, SYNCHRONY AND JOINT ACTION

On the emergence of inter-brain synchrony and spontaneous movement coordination

Giacomo Novembre

Abstract

Real-time social interaction is associated with inter-brain synchronization (IBS) in several social species including humans. According to some authors, IBS might signify the process of sharing similar mental states and experiences with others. To date, we know very little about how this phenomenon emerges. In the current study, we aimed to identify whether the mere inter-personal visual contact between two individuals, in the absence of an explicit social task, is a sufficient condition for IBS to occur. We further investigated which specific social behaviors lead to the emergence of IBS. We asked pairs of participants to simply look at each other and act spontaneously, while we recorded neural activity (EEG), eye movements, body movements and facial expressions from both simultaneously. We parameterized IBS as the Pearson's correlation between the – electrode and sub-band specific – EEG power timecourses measured from the two individuals forming a pair. We compared IBS across conditions during which the participants forming a pair were or weren't able to see each other. This visual contact manipulation served to identity states of IBS that emerged as a consequence of observing a partner's behavior. We also included a baseline condition during which the two participants were placed in two different rooms. A cluster based permutation test revealed higher IBS during the with-vision condition, as opposed to both the no-vision and baseline conditions, in both beta (19-31 Hz) and gamma (31-95 Hz) bands. These effects had distinct topographies. IBS in the beta band had a right-central-posterior distribution, while IBS in gamma band had predominantly a parieto-occipital distribution. Next, using a modeling approach, we demonstrate that specific social behaviors such as eye-contact, smiling and body movement can indeed anticipate and cause the emergence of specific IBS states. Taken together, these results shed light upon the origins of IBS and might

pave the way for the development of a model accounting for the emergence of distinct kinds of IBS and their relationship to social behavior.

The hidden rhythm of interpersonal (sub-)movement coordination
Alessandro d'Ausilio

Abstract

Humans manifest remarkable sensorimotor coordination abilities as showcased in the skilful performance expressed by orchestras and dance ensembles. In multi-agent interactions, sensorimotor loops that are normally involved in the control of one's own movement must accommodate also for sensory data (e.g., visual feedback) informing about others' movement to adjust performance and ultimately co-adapt to each other. Yet, a mechanistic understanding of how sensorimotor control comes into place to enable interpersonal coordination is still lacking. By examining movement intermittency, we here open a window into the dynamics of visuomotor loop control during interpersonal coordination. Specifically, we analysed submovements, i.e., recurrent (2-3 Hz) force pulses that are naturally engraved in our kinematics and deemed to reflect intrinsic intermittency in (visual-based) motor control. Participants were asked to synchronize rhythmic (0.25 Hz) finger flexion-extension movements. Besides synchronization at the common movement pace, finger velocity shows 2-3 Hz discontinuities that are consistently phase-locked between the two interacting partners. Notably, submovements alternate in a seemingly counterphase pattern, showing highest probability ~200ms before as well as after submovements generated by one's partner. Further, when the real partner is replaced by an unresponsive partner – a dot moving according to a pre-recorded human kinematics – submovements systematically follow the dot submovements, indicating that movement intermittency is causally linked between partners. These results show that submovements are actively adjusted (inter-locked) during interpersonal coordination. Visuo-motor loop dynamics of interacting individuals can thus couple to optimize synchronization of the sense-and-correct process that is required for behavioural coordination.

Cortical systems for interpersonal goal directed interactions
Matteo Candidi

Abstract

Individuals' ability to control their hand movements to realize goal-directed reaching and grasping actions depend on activity of a fronto-parietal system which is known to be involved in both action execution and others' action prediction and understanding. These properties of the system make it a good candidate for supporting individuals' ability to combine observed and executed actions during interpersonal motor coordination which depend on the ability to 1) perform on-line imitative and complementary movements compared to those of our interaction partners in order to achieve a goal (thought to be dependent on the activity of the left anterior Intra Parietal Sulcus, aIPS), 2) spot and adjust to unforeseen movements from our partners. To study the cortical underpinnings of interpersonal goal representation and interpersonal error monitoring, we engaged individuals in an interactive reaching-and-grasping task that they needed to perform while coordinating and synchronizing with a (virtual or real) partner in front of them who performed either imitative or complementary reaching-and-grasping movements compared to their own. During the reaching-and-grasping interaction participants had to spot unforeseen changes in the behavior of their partner (i.e., errors), who could suddenly switch from a precision (directed to an upper target) to a power grasp (directed to a lower target) and were asked to adjust their behavior accordingly. We used motion kinematics recordings combined with inhibitory brain stimulation (Transcranial Magnetic Stimulation, TMS) of left aIPS and EEG methods to study the role of humans' left aIPS in mediating individuals' ability to perform imitative and complementary interactions, and the brain responses to interactional errors, respectively. We found that 1) Transitory inhibition of the left aIPS by TMS selectively impairs individuals' ability to synchronize with a partner during interpersonal complementary interactions, 2) observing an error in the behavior of our interaction partner triggers classical time (ERN, Pe) and time-

frequency (frontal theta band ERS) error-related neural responses, 3) the frontal theta band error response is in phase with theta activity of the visual area processing the image of the partner's hand, 4) interactive error-related EEG responses are locked to the error of the partner rather than to the individuals' behavioral adjustment to the errors. Thus, interactive behavior entail reformulating the concepts of "goal" and "error" and their neural underpinnings. Interpersonal coordination is crucial for observational learning and social processes and understanding their behavioral and neural underpinnings has the potential to allow restoring these fundamental functions in clinical and neurological patients.

SIMPOSIO

FREQUENCY BAND SPECIFIC MARKERS OF COGNITIVE AND SENSORIMOTOR PROCESSES

Task-dependent changes of topology and functional connectivity in the human brain

Ottavia Maddaluno

Abstract

Abstract: Background and aims Electrophysiological studies show that limbs movements produce a modulation within the rhythmic neuronal oscillations both in the alpha and beta frequency bands. Moreover, neuroimaging studies demonstrate that the sensorimotor brain regions are functionally coupled even during spontaneous activity. An open question remains on how these movements modulate the large-scale organization of the resting brain to ensure the flexibility of motor behavior and how individual characteristics such as manual dexterity modulate functional connectivity (FC). Materials: MEG data from the Human Connectome Project collected from 51 subjects during visual fixation or during a motor task (i.e., finger tapping with their left or right index and thumb or squeezing their left or right toes) were analyzed. Nine-hole peg test scores were analyzed as a measure of finger dexterity of the right. hand. Methods: Leakage-corrected band-limited power (BLP) correlation was reconstructed at source level across 164 node regions, parceled into 10 networks in α (6.3-16.5 Hz), low β (12.5-29 Hz) and high β (22.5-39 Hz) bands. Results: Limbs movements produce a decrease in FC despite a resilience of the topography in all bands. Moreover, foot movements produce a wide-spread topological reorganization across all brain, stronger between networks, especially in the low β band. Conversely, the number of decreased connections during hand movements is limited to a few networks. We conducted further analysis splitting participants into two groups accordingly to dexterity scores (i.e., high performers and low performers). Results show that low performers are characterized by an overall topological reorganization. By contrast, in individuals with high manual dexterity the BLP connectivity in the alpha band is similar between rest and motor tasks. Besides this stability, we found a task-dependent reorganization of the sensorimotor network (SMN) and dorsal attention network (DAN). Discussion: The resilience of FC topography during hand movements may reflect the adaptation of the brain to more common movements (i.e., daily routine interactions with the external environment are more commonly performed with the hands instead of the feet). By contrast, the stronger topological network reorganization during foot movements may be due to task novelty. In high performers, this resilience of FC is parallel to a reorganization of the task-dependent networks (i.e., SMN/DAN), especially in the alpha-band. Conversely, individuals with lower manual dexterity show a whole-brain reorganization in all bands. Conclusions: The frequency band-selective topological stability suggests that spontaneous alpha rhythm may serve as a prior of skilled/trained hand movements in the human brain.

Beta rebound as an index of somatosensory and motor communication

Pasquale Cardellicchio

Abstract

Somatosensory and motor areas act in concert to organize and control movements. Indeed, during voluntary movement, the somatosensory system not only passively receives signals from the external world but also actively processes them via interactions with the motor system. The process of somatosensory information and the control of movements seem to involve movement related beta band cortical oscillations, including beta rebound after execution and/or suppression of movement. The aim of our study was examined the contribution of efferent and afferent signals to the beta rebound. The rebound of beta oscillations, could be induced also in the absence of voluntary movement. This phenomenon is visible after transcranial magnetic stimulation (TMS) of the primary motor cortex. Otherwise, it follows somatosensory stimulations, underlining a critical role of somatosensory reafference in generating this beta rebound. In the experiment, we combined TMS on the primary motor area (hand representation) and electrical median nerve stimulation (MNS) at the wrist. Specifically, we applied electrical MNS to the right side followed by transcranial magnetic stimulation (TMS) on the left primary motor cortex after either 15 or 25 ms. Considering that the afferent volley reaches the somatosensory cortex after about 20 ms, TMS on the motor cortex was either anticipating or following the cortical arrival of the peripheral stimulus. By means the electroencephalographic (EEG) recording we tried to differentiate if the motor cortex is stimulated after preconditioning somatosensory areas or if the afferent volley reaches its cortical targets after the preconditioning of the motor cortex. The beta rebound in the left hemisphere (stimulated) is modulated in its lower frequency range (15–20 Hz) when TMS precedes the cortical arrival of the afferent volley. Beta rebound modulation is also induced in the right hemisphere, probably mediated by transcallosal connectivity between homolog areas. In this hemisphere (unstimulated), the increase is limited to the 15-ms delay in the middle frequency (20–25 Hz) and to the 25-ms delay in the upper frequency (25–30 Hz). This result show that multiple mechanisms of integration of sensory and motor signals may be at play, in parallel, in the beta band. Summary, we demonstrate that the temporal integration of afferent and efferent signals plays a key role in the genesis of the beta rebound and that these signals may be carried in parallel by different beta sub-bands.

The beta band as the spectral signature of control signals in the DAN during attentional reorienting

Sara Spadone

Abstract

AIMS. Endogenous allocation of spatial attention is controlled by the dorsal attention network-DAN comprising frontal (frontal eye fields-FEF) and parietal regions (superior parietal lobe-SPL and intraparietal sulcus-IPS, which respectively showed a causal role for reorienting and maintaining attention; Capotosto et al., 2013) that exert top-down modulation over the activity of visual regions. We analyzed the spectral signature associated with control signals involved in reorienting information processing across hemifields within the DAN. MATERIALS. To this aim, we recorded magnetoencephalographic (MEG) activity in eighteen healthy subjects during a continuous visuospatial attention paradigm (Spadone et al., 2015) that isolates attention processes (maintaining/reorienting), triggered by the presentation of cues, from target- and response-related activity. METHODS. The modulations of event-related desynchronization/synchronization (ERD/ERS) of oscillatory activity induced by the attention processes were analyzed in fMRI-defined regions of interest, previously defined as task-relevant in the same subjects. Moreover, the shift-related modulations of the directed functional connectivity between the task-relevant regions were analyzed using the Directed Transfer Function (DTF), a directional connectivity method based on the Granger causality approach in the frequency domain. RESULTS. Reorienting attention (shift cues) to a previously unattended location, as compared to maintaining the current location of interest (stay cues), produced a temporal sequence of ERD/ERS modulations at multiple frequencies in specific anatomical regions/networks. In particular, shift cues triggered a more sustained beta (β) band ERD peaking ~450 ms in regions of the DAN, especially FEF. This result is robust both at the whole-brain and at the single-subject level. This modulation is also behaviorally relevant as a more prolonged β desynchronization was associated with better and faster

visual discrimination. Moreover, shifting attention induced stronger directional interaction from right FEF to right SPL, in the early phase of reorienting that was specific for the β band. DISCUSSION. Several properties of the β ERD modulation observed in the DAN, especially in FEF, such as its spatial distribution, temporal profile, and relationship with behavioral performance are compatible with its involvement in the control of reorienting of attention, acting as to pre-establish novel (sensory) representations before the target arrives. In addition, the top-down control of attentional reorienting was exerted by the prefrontal DAN region and directed towards (medial) parietal regions using the beta band communication. CONCLUSIONS. The above findings corroborate the view that control signals in the DAN, which were exerted by prefrontal to parietal region during attentional reorienting, are be conveyed through a beta frequency channel. References: Capotosto P, Tosoni A, Spadone S, Sestieri C, Perrucci MG, Romani GL, Della Penna S, Corbetta M Anatomical segregation of visual selection mechanisms in human parietal cortex. The Journal of neuroscience: the official journal of the Society for Neuroscience (2013) 33:6225-6229. Spadone S, Della Penna S, Sestieri C, Betti V, Tosoni A, Perrucci MG, Romani GL, Corbetta M Dynamic reorganization of human resting-state networks during visuospatial attention. Proceedings of the National Academy of Sciences of the United States of America (2015) 112:8112-8117.

SIMPOSIO

PREDICTING MYSELF AND OTHERS: BETWEEN SENSE OF AGENCY AND BODY OWNERSHIP

Do I or Robot try to understand you? Active social perception

Dimitri Ognibene

Abstract

Humans naturally interact and collaborate in unstructured social environments that produce an overwhelming amount of information and, that, simultaneously, hide behaviourally crucial variables. Artificial perception systems' performances have greatly improved recently. However, the common solutions to deal with missing information induced by the sensory limits (e.g. occlusions and limited FOV), such as increasing the number and types of sensors, resulted in an escalation of costs, weight, and power demands, while some important information may still be missing. Active perception, or the adaptive control of sensors and of the perception process itself, is a key solution found by nature to cope with perceptual limits, as shown by the foveal anatomy of the eye and its high mobility. The design principles of systems that adaptively find and select relevant information are important for both Robotics and Neuroscience. For example, it has been recently shown that active perception mechanisms, which select part of the input also through spatial relations, may substantially improve learning performance and even enable zero-shot adaptation to new environments [1]. Active perception also plays a crucial role in agent-agent interaction, where agents not only have different and not evident intentions, beliefs, and perspectives, but they also may reciprocally hide relevant parts of the environment and their bodies. Information-theoretic models for predictive social interaction embodied in robots have shown the importance and complexity of balancing between the perception of the relevant affordances in the environment and that of other agents [2]. Finally, deep learning models of the theory of mind, have shown the possibility to learn to predict others' beliefs-determined behaviors, e.g.l active perception strategies, without the need for an external teaching signal about others' mental state. The ability to predict such behaviors is developed earlier and with higher accuracy, if the agent's mental state is used as a teaching signal, and, thus, adopting a meta-cognition architecture [3] that could be
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The role of consciousness in social active inference and the emergence of adaptive and maladaptive behaviors

Grégoire Sergeant

Abstract

In the footsteps of previous work on how to capture consciousness using projective geometry [1-2], we go one step further and modelize artificial agents embedded with a conscious like global workspace in interaction with other agents [3]. This workspace is defined by perspective taking on an ambient 'real world' common to all agents and is used to derive subjective affective quantities that assess pleasantness of a situation. Pleasantness of a situation then influences how the agent acts through affective and epistemic drive. This perceived pleasantness of a scene is influenced by the preferences of the agent and the believed perceived pleasantness of other agents making it capable of Theory of Mind. We will discuss how modifications of the parameters of the model can generate a variety of adaptive and maladaptive behaviours.

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Body ownership acts per se on conscious awareness of willed action

Lorenzo Pia

Abstract

Whenever humans achieve voluntary actions, we experience not only authorship over our movements (i.e., sense of agency - SOA) but also that those movements are executed through our own body (i.e., body ownership - BO). Despite these considerations how, and to what extent BO acts upon conscious awareness of willed actions is largely unknown. Here I will examine a variety of studies in which BO is somehow altered and the consequences on motor consciousness are investigated. Within a neuropsychological perspective, I will firstly discuss in brief how the arm of another person in those brain-damaged patients affected by a pathological embodiment of someone else’s body part modulated their sense of authorship. Results show that these patients tend to misattribute the movements of that ‘embodied’ arm to their own will. Then, I will present data coming from an ad hoc experimental manipulation on intact brain functioning in which it is induced the illusory ownership over an external object (i.e., a fake life-sized hand), and it is measured the impact on participant’s sense of agency at both explicit (i.e., subjective experience) and implicit (i.e., self-generated sensations are perceived less intensity than other-generated ones - Sensory Attenuation) levels. Results show that the movement of the fake hand is misattributed to the participant’s own will, and the stimulus intensity delivered by that hand is attenuated (exactly as it happened when the own hand delivered the stimulus). Lastly, I will examine the results of a study on stroke patient that tested if an experimentally induced illusory ownership over a walking virtual avatar can improve motor recovery. Results showed that only patients who experience the illusion during the training improved in their gait and balance deficits. Summarizing, all this evidence shows that SOA arises not only from motor-related signals but also from body-related information subserving BO. How could this be integrated within the current model of motor consciousness? SOA is thought to result as the match between predicted and actual bodily states, meaning that action preparation is a prerequisite for SOA. However, in the studies I presented here efferent signals were fully prevented. Hence, I suggest that (mis)representing the movement as belonging to the self might be embedded within one’s sensorimotor system as one’s own desired bodily state. This, in

turn, would trigger action preparation to achieve the specific changes in bodily states and, consequently SOA would arise.

SIMPOSIO

BRAIN RHYTHMS FOR PERCEPTION AND ACTION: DEFINING THE BUILDING BLOCKS OF HUMAN CONSCIOUS EXPERIENCE

Alpha and beta rhythms subserve spatio-temporal integration in perception

Luca Ronconi

Abstract

Background and aims: Our perceptual systems need to integrate sensory information across space and time in order to group elements belonging to the same object and create a stable and unique representation; at the same time, they need to segregate information belonging to different objects or events to avoid a fuzzy experience of the environment. Increasing evidence suggests that oscillatory brain activity might be a core mechanism for binding sensory information. However, the precise relationship between brain networks, neural oscillations in specific frequency bands, and the efficiency (or inefficiency) of such spatiotemporal binding remains far to be fully clarified. Recently, we have pursued different correlational and neuromodulatory studies intending to clarify such complex relationships between brain networks, their operating rhythms, and the ability to perform such spatiotemporal binding. Methods: We have measured temporal binding in the visual modality in paradigms that require the discrimination of visual stimuli presented at short time intervals in a single location or with bistable paradigms where two stimuli flashed at brief time intervals are sometimes fused together and interpreted as a single stimulus. Spatial binding has been measured in visual crowding tasks where the discrimination of a target object (e.g., a letter) is made difficult because of the presence of nearby objects. These paradigms have been studied with electro- (EEG) or magneto- (MEG) encephalography or probed in their causal relationship with brain rhythms using transcranial alternating current stimulation (tACS). Results: M/EEG and tACS findings converge in showing alpha-band activity in early visual areas (including V5/MT) as the main mechanisms responsible for temporal integration and segregation of stimuli over time. M/EEG evidence also suggested that slower rhythms (i.e. theta) in parietal areas were involved in binding information when also stimuli location changed (e.g. in apparent motion tasks), thus requiring spatiotemporal integration and motion extraction. Spatial binding as measured in visual crowding tasks seems to depend on beta oscillations in parietal areas; importantly, tACS within the beta band delivered over right parietal regions has been found to improve perception within a crowding regime. Discussion and Conclusions: Overall, our results show a clear relationship between specific spatiotemporal integration mechanisms and specific neural oscillations linked to the information flow between different areas along the human dorsal visual pathway, proving that neural oscillations might be a fundamental aspect to determine the spatiotemporal architecture for information processing in the visual system.

The influence of alpha and beta phase in visual perception and motor preparation

Domenica Veniero

Abstract

The phase of occipito-parietal alpha has been hypothesised to index the excitability of the visual cortex. In line with this idea, the alpha phase has been proposed to influence neural and behavioural responses to visual stimuli. Specifically, RTs or accuracy should be distributed according to the occipito-parietal phase within the alpha cycle, leading to fast/slow RTs and high/low accuracy depending on whether the stimulus is presented at the occurrence of a high or low excitability phase. Although this hypothesis is fascinating, empirical evidence are contradictory as some studies found an alpha-phase behavioural dependency whereas others did not. One aspect so far neglected is that the phase influence is usually investigated by

asking participants to generate a motor response, i.e., a button press to collect behavioural measures. The present study is designed to tease apart the relationship between occipito-parietal alpha-phase and motor preparation versus visual processing. To this aim EEG was recorded from 27 participants while performing a task entailing 3 distinct conditions in a block design. During the Move condition, they were asked to initiate a self-paced movement (i.e., to press a key on a keyboard); during the condition Respond, they had to press a key as soon as they perceived a visual stimulus; finally, for the Watch condition a visual stimulus was presented on the screen but no response was required. To test for a phase dependency of behavioural outcomes, we considered RTs for Move and Respond condition and C1 amplitude (an early ERP component generated by the visual cortex) for Respond and Watch condition. For each condition, trials were split in 2 groups according to the median of RTs or C1 amplitude, depending on the condition. The Phase Opposition Sum (POS) was then used to evaluate whether the behavioural outcome depended on the pre-stimulus or pre-movement alpha phase as recorded from occipito-parietal electrodes. Our preliminary results show a significant POS when considering C1 amplitude, but failed to show any significant effect when trials were grouped according to RTs. Therefore, the phase of the parieto-occipital alpha seems to affect the excitability of the visual area as indexed by the C1 component and consequently appears to be related to visual processing. On the contrary, parieto-occipital alpha does not seem to influence the motor response, as we did not find any difference in phase for slow vs fast motor response.

The motor rhythms of visual perception

Alice Tomassini

Abstract

Effective behavior relies on a dynamic interplay between motor and sensory functions. Whereas this interplay has been variously modelled at the computational level, little is known about how it is actually realized at the neural level. A growing stream of research indicates that sampling of sensory data may routinely operate in a discontinuous, rhythmic way and such rhythmicity can be locked to motor behavior (e.g., eye movements). I will present behavioral and neurophysiological data suggesting that visual information sampling is not just temporally locked to the overt movement dynamics, but it is synchronized to the internal, covert, motor dynamics. We asked human participants to perform continuous isometric contraction while detecting unrelated and unpredictable near-threshold visual stimuli. The motor output (force/EMG) shows zero-lag coherence with brain activity (recorded via EEG) in the beta-band, as reported in previous works. On the contrary, cortical rhythms in the alpha-band systematically precede the motor output by almost 200 milliseconds. Importantly, visual performance is facilitated when cortico-motor alpha (not beta) synchronization is enhanced immediately before stimulus presentation onset. These findings demonstrate an ongoing coupling between visual processing and motor control, suggesting the operation of an internal and alpha-cycling visuomotor loop.

Tuning alpha frequency and amplitude dissociates perceptual accuracy and confidence

Vincenzo Romei

Abstract

Aims. It’s commonly held that what we see and what we believe we see are overlapping phenomena. However, dissociations between sensory events and their subjective interpretation occur in the general population and in clinical disorders, raising the question as to whether perceptual accuracy and its subjective interpretation represent mechanistically dissociable events. Here I propose that brain waves oscillating between 7 and 13 times per second, namely alpha waves, represent the building blocks of our conscious experience. Specifically, alpha speed accounts for the pace of sensory sampling, accumulating sensory evidence and controlling perceptual accuracy (i.e. objective performance); alpha amplitude accounts for internal expectations, setting individual prediction and controlling response confidence (i.e. subjective bias). Materials and Methods. First, the hypothesized associations were investigated by means of EEG recordings during a perceptual task, where measures of perceptual accuracy and subjective judgments

were collected (Experiment 1). Second, the hypothesized association was causally probed by means of online rhythmic Transcranial Magnetic Stimulation (rhythmic-TMS) in three groups of participants: 1) by occipital entrainment at the individual alpha frequency (IAF); 2) slowing-down IAF by 1Hz; 3) speeding-up IAF by 1Hz (Experiment 2). Results. Results of Experiment 1 showed an implication of alpha-amplitude in perceptual decision confidence, while alpha-frequency influenced the level of objective accuracy. Results of Experiment 2 showed objective accuracy to be best predicted by pre-stimulus alpha speed modulations: induced faster vs. slower pre-stimulus alpha oscillations led to higher vs. lower task accuracy, not confidence. Moreover, alpha-amplitude modulations selectively reflected the degree of subjective bias, with higher vs. lower alpha-amplitude leading to lower vs. higher subjective confidence ratings, not accuracy. Discussion. By means of combined EEG and rhythmic-TMS in human observers, I provide for the first time causal evidence that the frequency of alpha oscillations is the best proxy of objective accuracy (with faster alpha frequency accounting for higher accuracy), whereas alpha amplitude best predicts the level of subjective conscious perception (with alpha amplitude inversely related to subjective confidence). Mechanistically, this links alpha frequency to the neural pace of information sampling, and alpha amplitude to the level of neural excitability and conscious access to both signal and noise. Conclusions. Thus, I directly demonstrate here that the processing of visual information and its subjective interpretation (i.e subjective confidence), which are strongly inter-dependent in everyday life, are dissociable in terms of neural mechanisms in oscillatory activity, and can be selectively modulated by non-invasive neurostimulation.

SABATO 2 OTTOBRE 2021

SIMPOSIO

EEG BIOMARKERS UNVEIL ABNORMAL NEUROPHYSIOLOGICAL MECHANISMS IN PATIENTS WITH ALZHEIMER'S AND LEWY BODY DISEASES

The interaction between neuropsychology and the study of brain networks in neurodegenerative disorders

Davide Quaranta

Abstract

Cognitive impairment due to neurodegenerative disorders is one of the main challenges of modern neuroscience, from both the clinical and theoretical point of view. The most common form of neurocognitive disorder is represented by Alzheimer's Disease, that is consequence of the progressive accumulation of amyloid and neurofibrillary tangles, and of neuronal loss beginning in the medial part of temporal lobes. Other common forms of neurodegenerative dementias are represented by: Frontotemporal Dementias, a group of diseases mainly characterized by behavioral and language disorders, associated to neuropathological changes in frontal and temporal lobes; and Dementia with Lewy Bodies, an alpha-synucleinopathy characterized by parkinsonism associated to cognitive fluctuations and visual hallucinations. The traditional neuropsychological approach to cognitive disorders is based on the correspondence between the neuroanatomical structures affected by neurodegeneration, and the impairment of specific cognitive functions. The reliability of this approach has been confirmed by a great amount of papers, such as the ones about the impairment of episodic memory in Alzheimer's disease, which is strongly associated to changes in medial temporal lobes. However, the description of large cortical-subcortical networks, such as the Default Mode Network (DMN), the Central Executive Network (CEN) and the Salience Network (SN) has prompted novel neurophysiological and neuroimaging investigations on the functional substrates of cognitive impairment in dementias. In fact, large cerebral networks has been demonstrated to be involved in several cognitive mechanisms, such as memory (DMN), executive functions (CEN), and attentional switch (SN). Studies on neurodegenerative disorders have shown that cerebral areas affected by early neuropathological changes play a crucial role in large brain networks. On the other hand, impaired connectivity involving brain networks (for example, DMN in Alzheimer's

Disease, and CEN in Frontotemporal Dementia) has been described, and put in relationship with typical cognitive changes. Such evidence suggests the need for novel neuropsychological approaches that could be sensitive to early changes in brain networks.

EEG functional connectivity in cognitive domains: method and application to Default Mode Networks

Francesca Miraglia

Abstract

A relatively new approach in neurodegenerative diseases is the study of brain connectivity networks through graph theory. In fact, graph theoretical analysis provides a general language that enables to disentangle the pathological processes such as cortical atrophy and functional disruptions, and could support to understand how this processes are associated with each other to origin the disease propagation along specific routes.

Recently, because of the putative association between the Default Mode Network (DMN) and working memory, cortical activations of the DMN have been investigated to assess the underlying physiopathology of Alzheimer's disease (AD) and of a prodromal stage of dementia as Mild Cognitive Impairment (MCI). In particular, the neurophysiologic approaches with quantitative electroencephalographic (EEG) techniques can allowed a large scale recruitment and disease progression analysis due to the fact that EEG is a low cost, largely diffuse and non invasive technique allowing a cost-effective large population screening. This talk will summarizes the methodological advances in the application of graph theory analysis on EEG data in the cognitive impairment with a focus on DMN functional alterations, as they could reflect an abnormal flow of brain information processing that could be associated to a possible status of pre-dementia.

Event-related oscillatory coherence in patients with dementia and mild cognitive impairment due to Alzheimer's disease

Görsev Yener

Abstract

Objectives: EEG related methodologies including event-related oscillatory response (EROs) coherence have a potential to reflects brain functional connectivity. EROS are elicited after a stimulation, mostly a cognitive task such as oddball paradigm. They provide information on brain dynamics with an excellent time resolution despite a low spatial resolution. Disconnection among neural networks is considered to be main reason for impairment both in cognition and daily functioning. The Alzheimer's disease spectrum includes patients at mild cognitive impairment (MCI) and dementia (ADD) stages. The main difference between these stages is the preserved daily functioning in MCI. The aim of this study was assessing brain EROs functional connectivity of the mild cognitive impairment and dementia due to Alzheimer's disease with healthy elderly subjects. Materials: The study included 43 individuals with MCI, 43 with ADD, and 68 demographically-matched healthy elderly controls (HC). Method: Delta, theta, alpha, beta, gamma bands EEG event-related imaginary coherency (ICoh) was measured during an oddball paradigm. Inter-hemispheric, midline and intra-hemispheric ICoh values were compared in ADD, MCI and HC groups. Results: ADD patients display decreased theta, delta, alpha EROs connectivity during the cognitive task compared with MCI and healthy controls. The MCI group shows higher theta EROs connectivity during the cognitive task compared with healthy control. Discussion: Recent literature suggests hyperconnectivity occurs at the early stages, i.e. MCI stage of Alzheimer's disease, whilst hypoconnectivity develops at dementia stages. Conclusions: Hyperconnectivity may be a compensatory mechanism to maintain brain functional connectivity at the MCI stage. References: Başar E, Güntekin B, Tülay E, Yener GG. Evoked and event related coherence of Alzheimer patients manifest differentiation of sensory-cognitive networks. Brain Res. 2010;1357:79-90. doi: 10.1016/j.brainres.2010.08.054. Güntekin B, Saatçi E, Yener G. Decrease of evoked delta, theta and alpha coherence in alzheimer patients during a visual oddball paradigm. Brain Res. 2008;1235:109–116. Bonanni L, Moretti D, Benussi A, Ferri L, Russo M, Carrarini C, Barbone F, Arnaldi

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Event-related oscillatory power density and phase-locking in patients with Parkinson's and Lewy body dementias

Bahar Güntekin

Abstract

Objectives: Studies on Event-Related EEG Brain Oscillations presented essential results on understanding cognitive brain function and cognitive decline in different pathologies. The present research aimed to show the potential electrophysiological indicators of cognitive decline in Parkinson's disease dementia (PDD) and dementia with Lewy bodies (DLB). Materials and Methods: EEG of 15 cognitively normal PD (PDCN) patients, 22 patients with mild cognitive impairment (PDMCI), 11 patients with PD dementia (PDD), 17 patients with DLB, and 25 healthy controls were recorded during visual and auditory oddball paradigms. Event-related power spectrum and phase-locking were evaluated in delta and theta frequency bands. Results: Event-related delta and theta power and phase-locking increased with a cognitive load in healthy subjects but these responses decreased in PD patients who have mild cognitive impairment and dementia ($p<0.05$), and as well as in patients with DLB ($p<0.05$). The results indicated that delta and theta responses in PD patients decreased gradually as the cognitive decline increased, being worse in the PDD patients. Discussion: The present study showed that PDD and DLB both have abnormal delta and theta responses compared to healthy controls. Both PDD and DLB had a severe reduction of delta-theta power and phase-locking, which are the essential signs of cognitive decline. Although the decrease in frontal-central theta phase-locking was slightly worse in DLB group, no significant differentiation between PDD and DLB patients was found. Conclusions: The present study showed that PDD and DLB patients had similar, severe reductions of delta and theta responses, which shows the severity of the cognitive decline in both groups of subjects. Delta and theta responses during oddball tasks may be useful neurophysiological biomarkers of cognitive decline in dementia patients. Acknowledgments: This work (grant number 214S111) was supported by the Turkish National Science and Research Council (TUBITAK).

SIMPOSIO
TOWARDS AN OPEN AND REPRODUCIBLE SCIENCE: ITALIAN REPRODUCIBILITY NETWORK

From registered reports to large-scale collaborative projects

Marta Bortoletto

Abstract

Low reproducibility of findings is a current issue in life sciences in general, and in the field of neuroscience and psychology in particular. Factors that probably are contributing to this problem include small sample sizes, undisclosed flexibility in analysis processes and bias in scientific publications. The scientific community is promoting tools and strategies to improve the quality and transparency of scientific research and overcome the reproducibility crisis. Among these, Registered Reports (RRs), an article format that involves an initial peer review process before data collection, is a tool that is increasingly expanding. From 2013 to today, the evolution of registered reports has already been significant, with an ever-increasing number of journals that offer this option as a standard format or within special issues. In this talk, the advantages and disadvantages of registered reports will be discussed with reference to both the literature on the subject and to our direct experience. Specifically, we have employed this article format for a transcranial magnetic stimulation experiment on motor representation in shared actions that is in the final stages of publication. Finally, differences between registered reports, pre-registration and clinical trial

registration will be highlighted. Another tool that is being promoted by the scientific community to overcome the reproducibility crisis are the numerous international network initiatives and projects in which the promoters provide a coordination service between laboratories and review of experimental procedures. Among these, the Peer Community in Registered Reports will be explored, a community of scientists that aims to review and recommend articles submitted as registered reports before they are published in a scientific journal and EEGmanylabs, an initiative that aims to replicate experiments with electroencephalograms (EEG) and with event-related potentials (ERPs) that have had a high impact in the literature.

Data sharing: an overview of practical issues and theoretical implications

Vittorio Iacovella

Abstract

Data sharing is often considered a mere technical operation to be carried out in response to specific requests from someone else: you select a few files, upload them somewhere and forget about it. In this contribution, we will discuss how sharing something means instead to rethink in a systematic way all the operations leading to the construction of every kind of research - related information. In this we will be helped by the FAIR principles - Findable, Accessible, Interoperable and Reusable [1], which will be introduced and discussed both from an abstract / scientific point of view, and from a more practical one. We will argue about how all the procedures related to sharing should not be thought as static and accomplished once and for all: instead, it's an ongoing process which is going to be updated as a consequence of updating tools and requests. We will also point out that sharing procedures are not supposed to be applied just to data files but for several kinds of research - related products. We will finally conclude that the target of sharing is not necessarily someone else: the way in which you prepare your products for exposing them to the public is crucial to the work routine of your future self as well. [1] Wilkinson, M., Dumontier, M., Aalbersberg, I. et al. The FAIR Guiding Principles for scientific data management and stewardship. Sci Data (2016) 3, 160018.

The multiverse approach for a better data analysis in developmental psychophysiology: the case of pupillometry

Giulia Calignano

Abstract

A heterogeneous focus on the replicability crisis is evident across subfields of psychological research, with a reduced sensitivity in developmental psychophysiology. On one side, the present talk aims at shedding light on some issues concerning data management and analysis to contribute at solving the current reproducibility crisis; on the other side, it will propose compelling solutions by offering practical advices and open materials useful to reach higher level of transparency and replicability thanks to a multiverse approach [1]. Specifically, it will be presented an example of how to adopt a multiverse approach with pupillometry data. Indeed, the analysis of pupil dilation is widely implemented in developmental psychophysiology to investigate resource allocation and attention deployment [2]. However, for pupil dilation as for many psychophysiological indexes, data measurement, filtering and modeling require increasing and hierarchical levels of arbitrariness that are rarely shared with the scientific community. For instance, given the same dataset reporting pupil diameter variation across time, even subtle differences in the (i) pre-processing phase, i.e., baseline, area of interest, outliers, and (ii) modelling phase, i.e., smoothers, family distribution, fixed and random structure, can dramatically change the parameters estimation and thus, the conclusion of a study. With the aim of improving reproducibility and robustness of study findings, a practical and reproducible example will be proposed using the R software [3] to perform a multiverse analysis with real (i.e., noisy) pupillometry data from 12-month-olds. Developmental psychophysiology needs a shift of paradigm: we should open a window of plausible results instead of

acratically accepting a unique (often unsatisfactory and reductive) conclusion drafted on an unthoughtful data analysis. References: [1] Steegen, S., Tuerlinckx, F., Gelman, A., & Vanpaemel, W. (2016). Increasing transparency through a multiverse analysis. Perspectives on Psychological Science, 11(5), 702-712. https://doi.org/10.1177/1745691616658637 [2] Hepach, R., & Westermann, G. (2016) Pupillometry in Infancy Research, Journal of Cognition and Development, 17:3, 359-377, DOI: 10.1080/15248372.2015.1135801 [3] R Core Team (2020). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

Good lab management practices from a reproducibility perspective

Davide Crepaldi

Abstract

After it was exposed that several research results in Psychology and Neuroscience might be hard to replicate, or plainly false, we all became much more aware, as a community, of the common practices that lie at the heart of the low reliability of our science. In this talk, I will argue that abandoning those practices seems easy like turning a couple of knobs, but is in fact extremely difficult — impossible, quite likely — if one doesn’t change the entire pipeline of a research project from Day 1. This new way of doing science day-to-day is based on three fundamental principles. First, any material is shared, within the research team early on, and then with the world. Second, any change to that material is logged, so that other researchers and the public can see exactly how that material came to be. Third, this material is created via line coding, instead of button presses. These three simple principles guarantee transparency, replicability and, ultimately, that we progress as a competitive-cooperative community, thus guaranteeing the best use of the resources that the taxpayers bestow on us. Realising these principles might sound hard, but in fact there are tools out there that allow any researcher to embrace them fairly easily; I will point at these tools and illustrate how they can be useful not only to work more ethically, but also to make our life easier and grant us more visibility, particularly for early-career researchers.

GIOVEDI’ 30 SETTEMBRE 2021

COMUNICAZIONI ORALI

Probing the structure-function relationship of the corticospinal tract: a dMRI-TMS approach

Sonia Betti, M. Fedele, U. Castiello, L. Sartori, S. Budisavljevic

Abstract

The corticospinal tract (CST) is the principal motor descending pathway for voluntary movements; however, how its inter-individual anatomical variability affects the function of the human motor system is still a matter of investigation. Inconsistent results come from a few studies that have used brain stimulation to explore the relation between corticospinal excitability â€“a measure reflecting the CST function â€“ and the microstructural organization of the CST (Herbsman et al. 2009; HÃ¼bers et al. 2012). This study uses advanced diffusion magnetic resonance imaging (dMRI) tractography based on the spherical deconvolution and transcranial magnetic stimulation (TMS) to explore how microstructural and volumetric properties of the CST modulate the corticospinal excitability and conductivity. In two experimental sessions, tractography and TMS data were acquired from nineteen right-handed healthy individuals. The primary motor cortex (M1) portion of the CST was dissected and both volumetric (i.e., number of streamlines) and microstructural (i.e.,
fractional anisotropy) properties of the tract were assessed. Single-pulse TMS was administered to the hand region of both left and right M1s and motor-evoked potentials (MEPs) were recorded from the first dorsal interosseous muscles of the contralateral hand. In this way, the resting motor threshold (rMT) and

the MEP amplitude and latency were measured to probe the excitability and conduction properties of the CST. Results showed that increased corticospinal excitability and conductivity is associated with a bigger corticospinal descending pathway, as well as with increased microstructural coherence and organization. Our results shed light on the neurophysiological correlates associated with the inter-individual variability of the CST and show that the facilitation of the corticospinal excitability in the ipsilateral M1 is associated with the macro- and micro-structure of the corticospinal descending pathway. These findings may impact our understanding of the neuroanatomical basis of TMS as well as the study of the human motor system in both health and disease.
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Neurophysiological correlates of ventral premotor cortex to primary motor cortex cortico-cortical paired associative stimulation

Andrea Casarotto, E. Dolfini, P. Cardellicchio, L. Fadiga, G. Koch, A. D'Ausilio

Abstract

The cortico-cortical paired associative stimulation (cc-PAS) is a TMS protocol that induce Hebbian-like plastic changes between two interconnected areas. Interactions between the ventral premotor (PMv) and the primary motor cortex (M1) are crucial for generating grasping motor command. However, precise knowledge about the physiological modifications produced by cc-PAS in PMv-M1 network is still lacking. To fill this gap, we applied cc-PAS protocol to PMv-M1 circuit, investigating modifications induced on different neurophysiological indices. We performed single and paired pulse TMS protocols, before and after cc-PAS, to evaluate: motor evoked potentials (MEPs), intracortical facilitation (ICF; interstimulus interval (ISI) of 15 ms), short intracortical facilitation (SICF; ISI of 2.5 ms), short intracortical inhibition (SICI; ISIs of 1 ms and 3 ms), long intracortical inhibition (LICI; ISI of 100 ms). The cc-PAS protocol was composed by one-hundred pairs of pulses delivered at 0.25 Hz for 6 min to repeatedly activate the PMv-to-M1 connections. In each pair, M1 stimulation followed PMv stimulation by 6 ms (Koch et al., 2010). The post-PAS acquisitions were performed 10 min (post-10) and 30 min (post-30) after the end of cc-PAS protocol. The results showed that cc-PAS induced long lasting changes in the activity of different M1 intracortical circuits. We found a significant reduction of SICF at post-10 and post-30. Moreover, MEPs amplitude significantly increased at post-30. Finally, we observed a significant increment of LICI at post-10 and at post-30. Other evaluated indices did not show any modulation. These results show that PMv-to-M1 cc-PAS protocol modulates the activity of multiple dissociable neurophysiological mechanisms within M1. Particularly, results on MEPs reflect an increase of corticospinal excitability, depending on the sum of all inputs to the pyramidal projecting neuron. At the same time, LICI increment reflects larger slow inhibitory post-synaptic potentials mediated by GABAB receptors (Werhahn et al., 1999) while GABAA-related indexes remained unaffected. Concurrently, the reduction of SICF likely reflects changes in an interneuronal circuit that receives the input from PMv. The changes occurred at an ISI of 2.5 ms probably reveals an augmented I2 wave. Indeed, the periodicity of SICF overlaps with that
of the I-waves (Avanzino et al., 2007) and later I waves can reflect activity in cortico-cortical pathways transmitting information from other cortical areas. Hence at rest, the strengthening of the PMv-to-M1 connection leads to long lasting complex neurophysiological modifications. Further studies should elucidate how these modifications may be involved in the visuomotor transformations during precise grasping.
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Real-Time assessment of inhibition deficits in Parkinson's disease by combining TMS and EEG

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Abstract

Abnormal functioning of inhibitory processes in Parkinsonâ€™s disease (PD) has been investigated and also linked to major clinical manifestations of the disease, such as dyskinesias. The combination of transcranial magnetic stimulation and electroencephalography (TMS-EEG) represents a novel approach to directly investigate cortical activity and connectivity in a non-invasive way [1]. In this study, we used TMS-EEG during the execution of a Go/No-Go task, to investigate inhibitory processes in a sample of PD patients. 20 PD patients were recruited and tested in ON condition, they were compared with 20 age-matched healthy volunteers (HV). Our experimental session consisted of an EEG recording during TMS of the most affected primary motor cortex (M1), while participants were involved in a Go/NoGo task. A total of 140 TMS pulses were delivered after 150 ms from the task cue (70 in a Go condition, 70 in a NoGo condition). We also recorded 140 trials (70 Go, 70 NoGo) without TMS to record an ERP response later subtracted to the TMS-EEG trials. Global cortical activity did not show any difference between HV and PD patients ($p>0.05$) Topographical maps showed a larger negativity at 100 ms in a left fronto-central cluster of HV, compared to PD patients. At local M1 level, HV showed a higher TMS-evoked N100 in the NoGo compared to the Go condition whereas PD patients showed a smaller TMS-evoked N100 ($p<0.05$), which was not modulated by the task condition. Reaction times (RT) of PD patients were slower compared to HV ($p<0.05$). In addition, the number of false alarms in PD patients, but not in HV, were inversely correlated with TMS-evoked N100 amplitude. Our results suggest the presence of a deficit in the motor inhibitory mechanism required in the task for PD patients. This is highlighted from the lack of modulation of the TMS-evoked N100, which is known to be higher during the engagement of an inhibitory mechanism [2,3], as we observed in the HV group. Importantly, we observed higher rates of FAs in PD patients, a well-known measure of disinhibition, were inversely related with the TMS-evoked N100 amplitude. We provide a demonstration of a cortical inhibitory deficit in PD patients. These results support the reliability of the TMS-evoked N100 as a marker of inhibition. Our study highlights the sensitivity of the TMS-EEG technique in detecting abnormal neuronal mechanisms.

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Intrinsic motor network connectivity predicts corticospinal excitability

Laura Marzetti, A. Basti, F. Chella, R. Guidotti, J. Metsomaa, C. Zrenner, U. Ziemann, R. Ilmoniemi, G. Romani, V. Pizzella

Abstract

1.The aim of this study was to evaluate whether and how functional connectivity in humans is related to corticospinal excitability, as indexed by MEPs induced by transcranial magnetic stimulation of the cortical motor hand area. 2.Nine right-handed adults with no history of neurological and/or psychiatric pathologies were enrolled after obtaining written informed consent. Participants underwent a concurrent EEGâˆ’TMS experiment at the University of Tuebingen. The study was approved by the local ethics committee and was conducted in accordance with the Declaration of Helsinki. 3.About 1000 biphasic TMS pulses were delivered to the left primary motor cortex (M1) using a neuronavigated figure-of-eight coil (interstimulus interval 2Â±0.25 s) at an intensity of 110% of the resting motor threshold. Electromyography was acquired from the abductor pollicis brevis and first dorsal interosseous muscles of the right hand. EEG was recorded using a TMS-compatible 128-channel electrode cap. Bad channels and trials were identified for removal by the statistics of the channel-wise noise signals (variance and range) estimated by the spatial Wiener filtering. Peak-to-peak MEP amplitudes were determined from cleaned EMG. All further EEG analyses were conducted in the pre-stimulus interval (about 1 s). First, independent component (IC) analysis was used to obtain cleaned signals from ICs with a clear peak at the mu frequency. Then, source activity was estimated (eLoreta) and the location of the maximum mu power was used as a seed for single-trial functional connectivity analysis (imaginary part of Phase Locking Value). For each participant, the average MEP values in trials with high functional connectivity (HFC) and low functional connectivity (LFC), obtained by median split, were extracted, and their relative deviation with respect to MEP average across all trials (ALL) was calculated. From functional connectivity, time lags of the coupling between the seed and the whole brain were obtained. 4.For all participants, source level power maps at the mu frequency peaked at left M1. Group-averaged functional connectivity highlighted a statistically significant coupling of lM1 to Supplementary Motor Area (SMA) and to right primary motor area (rM1). For both regions, MEP values in HFC trials were higher than MEP values in the LFC trials (modulation about 4%). Finally, for HFC trials, time lags for lM1â€“SMA (6.2â€“8.8 ms) were significantly lower than time lags for lM1â€“rM1 (11.2â€“13.8 ms). 5.To our knowledge, this study shows for the first time a direct relation between intrinsic motor network connectivity and corticospinal excitability. References: This project has received funding from the European Research Council (ERC Synergy) under the European Unionâ€™s Horizon 2020 research and innovation programme (ConnectToBrain; grant agreement No 810377). This abstract reflects only the authorsâ€™ view and the European Commission is not responsible for any use made of the information it contains.

Investigating the interaction between tACS aftereffects and cortical natural frequencies: a TMS-EEG study

Alberto Pisoni, E. Arrigoni, L. Romero Lauro

Abstract

tACS is a NiBS technique delivering oscillating electrical current to the neural tissue through the scalp. While online tACS effects rely in entraining large neural populations, compelling evidence of a consistent pattern of offline effects is still lacking (Veniero et al., 2015). Previous works highlighted the importance of individual frequency-dependency of tACS after-effects (Zaehle et al., 2010). However, the interplay between tACS frequency-specificity and endogenous oscillatory activity (natural frequency, Rosanova et al., 2009) of the targeted cortico-thalamic module needs further investigation. Here, we assessed with a combined TMS-EEG approach whether tACS effects are predominant in the targeted cortical areaâ€™s natural frequency regardless of the applied stimulation protocol. We measured cortical excitability and oscillatory activity following tACS of BA7 at its natural frequency (i.e. beta-rhythm) compared to a control frequency (i.e. gamma-rhythm). preliminary data of eight subjects are available. Participants underwent two TMS-EEG sessions. TMS single pulses were delivered over the left PPC, before and after 15 minutes of tACS in the beta
(18Hz) and gamma (40Hz) band over the right PPC. TMS-evoked potentials were recorded from 60 scalp electrodes. Cortical excitability of left PPC increased after beta-tACS, between 150ms and 170ms post-TMS,

while it decreased in frontal electrodes following gamma-tACS. Beta-band activity desynchronization was significantly higher in fronto-parietal regions between 0 and 250ms after TMS pulse on right PPC. A decrease in beta-power at left fronto-central sites was also reported after gamma-tACS. These preliminary results provide new insights about the link between tACS modulatory effects and the natural frequencies of the stimulated cortical regions, suggesting a complex modulation of interregional communication. References: Veniero, D., Vossen, A., Gross, J., & Thut, G. Lasting EEG/MEG aftereffects of rhythmic transcranial brain stimulation: level of control over oscillatory network activity. Frontiers in cellular neuroscience. (2015): 9, 477. Zaehle, T., Rach, S., & Herrmann, C. S. Transcranial alternating current stimulation enhances individual alpha activity in human EEG. PloS one. (2010): 5(11), e13766. Rosanova, M., Casali, A., Bellina, V., Resta, F., Mariotti, M., & Massimini, M. Natural frequencies of human corticothalamic circuits. Journal of Neuroscience. (2009): 29(24), 7679-7685.

Hierarchical interactions: behavioural and physiological effects of perceived and experienced social status

Sarah Boukarras, V. Era, M. Schepisi, V. Placidi, S. Panasiti, S. Garfinkel, H. Critchley, M. Candidi Lauro

Abstract

Objectives: Human beings are highly skilled in the ability to infer the status of their conspecifics and to modulate their behaviour accordingly. However, the complexity of human societies has generated a wide variety of hierarchies and strategies to climb them up. We present a series of studies investigating how a targetâ€™s social status influences participantâ€™s implicit preference for him/her (Experiment 1) and the ability to coordinate with him/her (Experiment 2) and how participantsâ€™ own status level influences their cardiac reactivity to positive and negative feedback (Experiment 3). Finally, we tested whether the pathway used by a target to acquire status (i.e., competence, dominance or virtue) predicts participantsâ€™ lying behaviour (Experiment 4). Materials: Experiments 1, 2, 3 â€“ Cooperative time estimation task. Experiments 1, 2 – Affect Misattribution Procedure - AMP (Payne et al 2005). Experiment 2 â€“ Joint Grasping Task â€“ JGT (Sacheli et al. 2012). Experiment 4 - Temptation to Lie Card Game - TTLCG (Panasiti et al 2016) Methods: Participants were engaged in a cooperative time estimation task with two confederates, resulting in a competence-based hierarchy. After the status induction, we measured participantsâ€™ implicit preference for the two confederates with the AMP (Experiment 1) and their ability to coordinate their reach-to-grasp movements with the two in the JGT (Experiment 2). In Experiment 3, we recorded participantsâ€™ cardiac activity during the game. In Experiment 4, participants read fictional profiles describing individuals who acquired high or low status either through competence, dominance or virtue and played with them a card game (TTLG), where they had the opportunity to either tell them the truth, lie to obtain a self-gain or lie to benefit the other. Results: Following the status-inducing procedure, participantsâ€™ implicit preference for the low status confederate decreased (Experiment 1), while their ability to coordinate with him was impaired depending on the implicit preference itself (Experiment 2). Contrary to our predictions, heart rate deceleration following negative feedback was stronger when the participant was at the top of the hierarchy (Experiment 3). Finally, preliminary results from Experiment 4 indicate that the tendency to lie in order to obtain a self-gain was increased when facing a high-status individual who obtain status through dominance.
Discussion: Research on social status is often narrowed on the effects of economical differences. Our results highlight the relevance of other dimensions in determining behavioural (implicit preference, motor coordination and moral choices) and physiological (autonomic correlates of performance monitoring) effects of status. References: Payne, B. K., Cheng, C. M., Govorun, O., & Stewart, B. D. (2005). An inkblot for attitudes: affect misattribution as implicit measurement. Journal of personality and social psychology, 89(3), 277. Sacheli, L. M., Candidi, M., Pavone, E. F., Tidoni, E., & Aglioti, S. M. (2012). And yet they act together: interpersonal perception modulates visuo-motor interference and mutual adjustments during a joint-grasping task. PloS one, 7(11), e50223. Panasiti, M. S., Pavone, E. F., Mancini, A., Merla, A., Grisoni, L.,

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Body ownership constraints and consciousness: hand-perspective, but not hand-identity, affects the timing of visual awareness

Tommaso Ciorli, L. Pia

Abstract

1. Objectives: The feeling that our body belongs to us (i.e., body ownership) is triggered by the integration among those bottom-up incoming multisensory signals that constantly reach our body. However, a full and conscious sense of owning body parts requires some top-down mechanisms. As regards hands, it has been demonstrated that they are perceived as belonging to the own body if they are seen from a 1st (but not 3rd) person perspective1. Moreover, it has been shown that people implicitly recognize better their own rather than others' hands2. Here, we investigated whether these high-level components affect the access to conscious awareness of body parts with the breaking continuous flash suppression (b-CFS) paradigm3. We compared own-hands vs. other-hand stimuli presented in 1st PP/upright or 3rd/inverted orientations, and we measured the time a stimulus takes to break the visual suppression. 2. Materials-Methods: Eighteen right-handed participants were recruited, and their dominant hand was photographed in the same position, with the same luminance, and black and white transformed to control for low-level differences. Participantsâ€™ head was stabilized by a chinrest with a built-in stereoscope, allowing for binocular vision. Self/other hands were presented to one eye, competing for visual awareness with a dynamic Mondrian pattern presented to the other eye. Participants were instructed to respond as fast as they see even a part of the target breaking the suppression induced by the mask. RTs were recorded, log-transformed, and subjected to a repeated measure ANOVA with the factors handsâ€™ ownership and perspective. 3. Results: A main effect of perspective was found ($p<0.001$, Î·Â²p= 0.571), indicating that 1st PP hands break faster into conscious visual awareness. No effect for the factor ownership and the interaction were found. 4. Discussion: Previous evidence suggested that visual perspective and self-identity of hands are key features to generate a coherent sense that the own body belongs to us. Our result shows that the anatomical congruency of the 1st PP, but not anatomical identity, affected the timing of visual awareness for hands stimuli. We argued that handâ€™s perspective can be discriminated preconsciously with 1st PP being more salient and familiar to the self than 3rd PP, resulting in faster conscious access. Yet, handâ€™s ownership information might not be processed preconsciously or strong enough to influence the timing for visual awareness. 5. Conclusions: Our study shows that while handsâ€™ perspective can be processed preconsciously, to recognize its ownership conscious visual awareness is required. References: Blanke, O., Slater, M., and Serino, A. (2015). Behavioral, Neural, and Computational Principles of Bodily Self-Consciousness. Neuron 88, 145-166. 10.1016/j.neuron.2015.09.029. Frassinetti, F., Ferri, F., Maini, M., Benassi, M.G., and Gallese, V. (2011). Bodily self: an implicit knowledge of what is explicitly unknown. Exp Brain Res 212, 153-160. 10.1007/s00221-011-2708-x. Gayet, S., Van der Stigchel, S., & Paffen, C. L. (2014). Breaking continuous flash suppression: competing for consciousness on the pre-semantic battlefield. Frontiers in psychology, 5, 460.

The tactile knowledge of the visual body self

Mattia Galigani, M. Romeo, F. Genovese, B. Forster, F. Garbarini

Abstract

Influential views posit that we resort sensorimotor information (e.g., somatosensory, visual, proprioceptive, and motor) to recognize our own body effectors, whereas we usually distinguish other people's bodies by vision only [1]. The aim of the present work was to specifically investigate the role of somatosensory cortex (SCx) in self-hand recognition, by exploiting an EEG method 2, which allows examining visually driven processing of information in cortices other than visual areas, specifically over the somatosensory cortex.

Eighteen volunteers were presented with pairs of visual stimuli (duration: 300 ms), consisting of grey-scale pictures of the dorsum of right hands belonging either to the participants or to other people. Visual stimuli were administered in two scenarios, in the With Self scenario visual stimuli included the Self hand and a stranger's hand (Other1); in the Without Self scenario visual stimuli included two strangers' hands (Other2; Other3). In half of the trials, participants received a brief task-irrelevant tactile stimulation to the index fingers of both hands at the onset of the visual stimuli. We performed two separated EEG analyses, i) on visual evoked potentials (VEPs) elicited by visual-only stimuli and ii) on somatosensory evoked potentials (SEPs), obtained by subtracting the visual-only trials from visual-tactile trials (VEPs-free SEPs [2]), thus dissociating neural evoked activity in somatosensory areas during visual processing. When we compared the electrophysiological activity elicited by the visual-only stimulus, we did not observe any significant difference between conditions, thus suggesting that VEPs are not affected by the identity of the hand (Self vs Other1: t1,17 along the waveform always < 0.43; Other2 vs Other3: t1,17 always < 2.14). Crucially, in the VEPs-free SEPs analysis, we found that the visual presentation of the self-hand significantly magnified somatosensory activity as compared to the other-hand. In particular, the enhancement of somatosensory processing driven by self-hand recognition was present around SCx of both hemispheres but was maximal at Cp1 electrode from 127 to 500 ms (t1,17 = 4.50; p=0.0003). No significant differences emerged in the Without Self scenario (Other2 vs Other3: t1,17 along the waveform always < 2.12). To summarize, our findings clearly demonstrate the involvement of tactile information in self-hand visual recognition, as reveals the specific modulation of somatosensory evoked activity by the visual presentation of the self-hand. Therefore, the present results provide substantial evidence in favor of an integrated, multisensory network devoted to the recognition of the bodily self, where somatosensory cortex may constitute a crucial hub. References: Ferri, F., Frassinetti, F., Ardizzi, M., Costantini, M., and Gallese, V. (2012). A sensorimotor network for the bodily self. J. Cogn. Neurosci. 24, 1584-1595. Galvez-Pol, A., Calvo-Merino, B., and Forster, B. (2020). Revealing the body in the brain: An ERP method to examine sensorimotor activity during visual perception of body-related information. Cortex 125, 332-344.

Interoceptive accuracy moderates the relationship between blood pressure and pain perception

Giuseppina Porciello, A. Salaris, G. Calcagnini, C. Ottaviani, E. Mattei, B. Basile

Abstract

Objectives: Hypertension is one of the primary risk factors for cardiovascular disease, the leading cause of death worldwide. Literature shows that spontaneous or experimentally induced high blood pressure (BP) is associated with a reduced pain perception, a phenomenon called BP-related hypoalgesia (1). BP-related hypoalgesia is a dangerous risk factor interfering with the early detection of silent myocardial ischemia and infarction symptoms (e.g. chest pain). Previous literature highlights the key role of interoception (i.e. the ability to read and interpret signals coming from the internal organs) in pain perception, showing that people with low interoception are characterized by higher pain threshold and tolerance (2). Preliminary evidence also suggests that hypertensives have lower interoceptive abilities compared to healthy controls (3). Although these processes seem to be associated, the role of interoception in the phenomenon of BP-related hypoalgesia remains unknown. Materials and Methods: 27 healthy volunteers participated in the study (18 females; age: Mean Â± SD = 25.7 Â± 3.75 years). Measures of BP, interoceptive accuracy (performance in the
heartbeat counting task) and sensibility (scores on the MAIA questionnaire), and pain threshold (obtained by delivering painful electrical stimulations on participantsâ€™ left medial antebrachial cutaneous nerve) were collected. A moderation analysis was performed to estimate the role of interoception in moderating the relationship between BP and pain perception. Results: We found that both BP and interoceptive accuracy significantly predicted pain perception. Interestingly, also the interaction between the two was significant (b = -3.94, t = -2.18, p = 0.04). Simple slopes analysis showed that, while in people low (b = 2.23, t = 3.21, p = 0.004) or averagely accurate in perceiving their own heartbeat (b = 1.13, t = 2.57, p = 0.02), BP

positively predicted pain threshold (i.e. the higher the BP, the higher the pain threshold), this was not the case in participants who were very accurate at perceiving their own heartbeats (b = 0.04, t = 0.06, p = 0.95). Discussion and Conclusions: Given the association between interoception, BP and pain perception, we speculate that these processes rely on a common physiological mechanism, where a major role might be played by baroreceptors, i.e. the mechanoreceptors involved in the regulation of BP. Present preliminary findings pave the way for developing novel non-invasive treatments aimed to directly increase interoception to normalize pain perception in people suffering from hypertension. References: Makovac, E., Porciello, G., Palomba, D., Basile, B. & Ottaviani, C. Blood pressure-related hypoalgesia: A systematic review and meta-analysis. J. Hypertens. 38, 1 - 16 (2020). Pollatos, O., Fustos, J. & Critchley, H. D. On the generalised embodiment of pain: How interoceptive sensitivity modulates cutaneous pain perception. Pain 153, 1680 - 1686 (2012). Yoris, A. et al. Multilevel convergence of interoceptive impairments in hypertension: New evidence of disrupted body - brain interactions. Hum. Brain Mapp. 39, 1563 - 1581 (2018).

Modification of autonomic nervous system induced by focal vibration in acquired brain injury

Costanza Pazzaglia, C. Cuccagna, R. Fiori, L. Padua

Abstract

Objectives: It is well known that after an acquired brain injury (ABI), motor-sensitive and cognitive functions are compromised. Moreover, also the autonomic nervous system (ANS) is impaired (1). Heart rate variability (HRV) is the fluctuation in the time intervals between adjacent heartbeats. It represents an expression of the modulation of heart function by ANS (2). In the last decades, the application of focal vibration (FV) on tendons or muscles has been evaluated for the treatment of neurological acquired pathologies (3). The aim of our study was to test the possible effect on ANS of FV randomly applied on the upper limb on a sample of patients suffering from ABI, by recording HRV and compared to a control sample. Materials: A total of 10 patients with severe ABI and 6 healthy subjects (matched for sex and age) were enrolled. The study participants underwent FV stimulation, during which electrocardiographic activity was recorded to assess HRV. Method: FV stimulation was performed using EVM EVO (Endomedica, Italy), capable of delivering a focal vibratory stimulus at 100 Hz. The stimulus was randomly applied on the affected/not affected upper limb. 5-minute trace intervals were analyzed using HRV analysis in the frequency domain (Frequency Domain Heart-Rate Variability) with an evaluation of LFnu, HFnu and LF/HF parameters. Results: Results showed, in control subjects, a progressive reduction of LF/HF Ratio mainly due to an increase of HF during FV. Patients who were treated in the healthy upper limb showed a LF/HF Ratio trend similar to control group. Patients who were treated in the affected side showed a progressive increase of LF/HF Ratio mainly due to an increase of LF.
Discussion: FV is able to determine a modification of LF/HF Ratio that in healthy subjects and patients treated in non affected side is mainly due to an increase of parasympathetic activity. In the subsample treated in the affected side, FV determine a progressive increase of LF/HF Ratio mainly due to an increase of sympathetic activity. Conclusions: FV is able to modify the ANS. Moreover, we observed, in ABI subjects, differences that could depend both from side impairments of the autonomic fiber, as already observed in peripheral nervous system, and different central processing of ANS afferences. References: Vistisen ST, Hansen TK, Jensen J, Nielsen JF, Fleischer J. Heart rate variability in neurorehabilitation patients with severe acquired brain injury. Brain Inj. 2014; 28(2):196-202. Task Force of the European Society of Cardiology the North American Society of Pacing Electrophysiology, 1996 Murillo N, Valls-Sole J, Vidal J, Opisso E, Medina J, Kumru H. Focal vibration in neurorehabilitation. Eur J Phys Rehabil Med. 2014 Apr; 50(2):231-42.

Respiratory phases shape electrophysiological and behavioural correlates of cardiac interoception

Andrea Zaccaro, E. Parrotta, G. Perrucci, M. Costantini, F. Ferri

Abstract

Interoception refers to the processing and representation of the internal states of the organism. A crucial contribution in this sense comes from respiration, which provides predominant interoceptive signals that have received so far little attention, being often discarded as artifacts. Recent studies have investigated the role of respiration in modulating important cognitive functions such as emotion recognition, memory, and visuo-spatial perception. These studies suggest that inhalation may prepare the brain to receive and process stimuli coming from the external environment [1]. On the contrary, few studies are investigating the effects of respiratory phases on stimuli coming from inside the body, such as the heartbeat. An index of cardiac interoception is the Heartbeat-Evoked Potential (HEP), an EEG event-related potential time-locked to the cardiac systole. The HEP reflects the cortical processing of cardiac activity and is linked to the conscious perception of heartbeats [2]. The present study aims at investigating the role of respiration in shaping the neural responses to single heartbeats, as measured via the HEP, during an interoceptive task (Heartbeat Detection Tapping Task [3]). Also, we tested the effect of the respiratory phases on interoceptive accuracy. We simultaneously recorded 64-channel EEG, single-lead ECG, and respiration in 20 healthy volunteers that performed a 10-minutes interoceptive task. To compute the HEP, we extracted and analyzed the EEG signals time-locked to the T-peak of the heartbeat. Then, we compared the HEPs detected during the inhalation phases with those detected during exhalation phases using a cluster-based permutation test, including all time points between 80 and 350 ms after the T-peak. Task-related HEP amplitude was significantly higher during the exhalation phase, as compared to the inhalation phase, in a time window ranging from 95 to 250 ms after the T-peak. Such modulation of the HEP was observed in a cluster of central-right electrodes. At the behavioural level, this effect was paralleled by increased interoceptive accuracy during exhalation, as compared to inhalation, as indexed by both the total number of correct responses [Hits] and the detection sensitivity [Hits/(Hits + Misses)]. The present findings suggest a respiratory-related modulation of cardiac interoception, both at the neurophysiological and behavioural levels. When individuals are focused on their
heartbeats, the brain better processes interoceptive information specifically during exhalation. Hence, respiration may tune the brain to switch from an exteroceptive processing mode to an interoceptive processing mode during exhalation, as opposed to a working mode of increased exteroceptive processing during inhalation. References: Zelano C, Jiang H, Zhou G, Arora N, Schuele S, Rosenow J, Gottfried JA. Nasal Respiration Entrains Human Limbic Oscillations and Modulates Cognitive Function. J Neurosci. 2016;36(49):12448-12467. doi:10.1523/JNEUROSCI.2586-16.2016 Coll MP, Hobson H, Bird G, Murphy J. (2021) Systematic review and meta-analysis of the relationship between the heartbeat-evoked potential and interoception. Neurosci Biobehav Rev. 2021;122:190-200. doi:10.1016/j.neubiorev.2020.12.012 McFarland RA. (1975) Heart rate perception and heart rate control. Psychophysiology. 1975;2:402â€“405. doi:10.1111/j.1469-8986.1975.tb00011.x

VENERDI' 1 OTTOBRE 2021

COMUNICAZIONI ORALI

Young adults and multisensory time perception: Visual and auditory pathways in comparison

Giovanni Cantarella, P. Bisiacchi

Abstract

Previous research has revealed the presence of a potential interference in multisensory conditions, leading to a trade-off between two senses (sight and hearing), when considering time perception tasks and a

sample of visually impaired children. The present study aimed at investigating behavioural peculiarities of human (healthy young adults) performances on this task. The time bisection task, which requires participants to compare reference durations with ones previously held in memory, is perfectly suitable to address these questions. Participants sat in front of an Intel-based, 64-bit Windows PC running Windows 7, connected to a high-resolution monitor in a quiet room (a silent cabin). In the auditory mode, audio headphones were provided. To elicit visual deprivation, in the corresponding session, each subject wore a mask over his or her eyes; ear plugs were introduced in the auditory deprivation condition. A within-subjects design was set up, whereby each subject was administered the same task. The experimental design was adapted for both visual and auditory modalities, to determine the contribution of these separate sensorial channels in performances. For each modality, 2 conditions were planned: (a) the presence or (b) the absence of visual or auditory deprivation during the ongoing temporal bisection task. In total, each participant carried out 4 experimental sessions: each session consisting of 4 blocks. This procedure allowed verification of whether the use of a single sensory modality could lead to a benefit in the estimation of time intervals. Experimental blocks were randomized between different orders of administration. A repeated measures ANOVA conducted on proportion of long responses (but also for Bisection Point and Weber Ratio), revealed a main effect of the variable Modality and the absence of significant effects for the variable Deprivation. These results can be interpreted as evidence of an optimal multisensory (audio-visual) integration of the auditory modality that leads to increased sensitivity to time (lower Weber ratio), but also to the absence of a trade off among the two senses, in the adulthood. Young adults did not elicit significant changes when manipulating the presence of sensory deprivation; they equally overestimated (higher proportion of long responses, lower BP) and showed better sensitivity to time (lower WR) in the auditory mode. Nevertheless, a higher variability in visual time estimation performances was highlighted. The demonstration of differences between conditions in visual temporal estimation performances shows further investigation of this sensory modality for time perception is required. References: Battistin T., Mioni G., Schoch V., Bisiacchi P.S. (2019), Comparison of temporal judgments in sighted and visually impaired children. Research in Developmental Disabilities, Vol. 95, 103499. Grondin, S. (2014). Why studying intermodal duration discrimination matters. Frontiers in Psychology, 5, 628. Church, R. M., & Deluty, M. Z. (1977). Bisection of temporal intervals. Journal of Experimental Psychology: Animal Behaviour Processes, 3(3), 216 to 228.

Magnetoencephalographic signatures of human perceptual decision making

Antea D'Andrea, A. Basti, A. Tosoni, F. Chella, V. Pizzella, L. Marzetti

Abstract

The intentional model of perceptual decision-making, inspired and formulated on the basis of neurophysiological evidence collected in the monkey brain [1], proposed that the decision process relies on an integrative mechanism of evidence accumulation implemented in the same cortical areas devoted to the selection and execution of the action response. Although these pivotal studies inspired several investigations on decision-making in the humans, only few studies have attempted to describe the human neural correlates of this mechanism [2]. Here, we aim at describing a human homologue of the decision variable and its frequency specific signature by exploiting magnetoencephalographic (MEG) recordings from sixteen subjects performing a continuous version of the classical Random Dot Motion task [3]. Participants were instructed to monitor a cloud of incoherently moving dots for intermittent targets defined by 1.9 s periods of coherent motion (coherency level equal to 30% - easy, 60% -medium, 90% - hard) and to indicate the prevalent direction of motion (i.e. leftward or rightward) by executing a spatially-correspondent saccadic eye movement. Statistical analysis (3x2 ANOVA) confirmed a main effect of motion coherence on behavior, with lower coherence associated with progressively slower and less accurate decisions. Sensor-level and source-level time-frequency (TF) analysis was performed to identify channel clusters and cortical activity with power modulations associated with the decision process. A cluster-based permutation test was used to assess the contrast between these time-varying modulations in the easy and

hard conditions, then a paired-sample t-test was used to assess differences in the modulation rate between the two conditions. Our results show that the saccadic decision was robustly affected by the amount of sensory evidence (i.e. motion coherence) available for the decision and that this effect was associated with an alpha band event-related desynchronization (ERD) that was spatially localized in a region of the posterior parietal cortex consistent with the definition of the human homologue of the monkey LIP area. We also found that the slope of the alpha-band ERD modulation significantly differed across the three sensory evidence levels, suggesting a possible human counterpart of the evidence-accumulation process described in monkeys. Moreover, in the same areas, a beta power modulation was observed, with a functional role conceivably related to the sensori-motor process of saccadic preparation. In accord with the intentional framework for perceptual decision-making, our results suggest that decision-making and action planning/execution are implemented in corresponding sensori-motor areas but rely on frequency-specific mechanisms associated with distinct functional roles. References: Shadlen, M. N., & Newsome, W. T. (2001). Neural basis of a perceptual decision in the parietal cortex (area LIP) of the rhesus monkey. Journal of Neurophysiology, 86(4), 1916â€“1936. http://www.ncbi.nlm.nih.gov/pubmed/11600651 Tosoni, A., Galati, G., Romani, G. L., & Corbetta, M. (2008). Sensory-motor mechanisms in human parietal cortex underlie arbitrary visual decisions. Nature Neuroscience, 11(12), 1446â€“1453. https://doi.org/10.1038/nn.2221 Kelly, S. P., & Oâ€™Connell, R. G. (2013). Internal and external influences on the rate of sensory evidence accumulation in the human brain. Journal of Neuroscience, 33(50), 19434â€“19441. https://doi.org/10.1523/JNEUROSCI.3355-13.2013.

The categorical representation of affect in ventromedial prefrontal cortex is independent from the sensory modality and visual experience

Giada Lettieri, G. Handjaras, E. Cappello, F. Setti, C. Frati, V. Bruno, M. Diano, A. Leo, C. Tinti, F. Garbarini, P. Pietrini, E. Ricciardi, L. Cecchetti

Abstract

Objectives. Affective abilities are crucial for survival and for human social interactions in daily life. Indeed, successful interplays in a complex social world rely on visual features (e.g., facial expressions, hand gestures) that convey one's emotional experience and allow others to interpret affective signals. Therefore, given the ubiquitous role of emotions and the importance of sight, the question of how they are experienced in the absence of vision naturally arises. Here we aim to assess whether the brain representation of emotions is sensory independent and may be affected by the congenital lack of visual experience. Materials and Methods. A group of 42 sighted individuals provided ratings of their moment-by-moment emotional experience during an audio-visual edited version (n=22, 11F; 30Â±3 years) or an audio-only (n=20, 8F; 36Â±16 years) of the live-action movie "101 Dalmatians" (52 minutes; Walt-Disney Pictures, 1996). Participants had to choose between 15 emotion categories (e.g., amusement, relief) to describe their affective state throughout the movie. Brain activity elicited by the same stimulus was measured in 20 sighted (audio-visual: n=10, 8F, 35Â±13 years; audio-only: n=10, 7F, 39Â±17 years) and nine congenitally blind (3F; 44Â±14 years) individuals, instructed to simply enjoy the movie in the fMRI scanner. Behavioral ratings were aggregated across subjects, so that in each timepoint we computed the proportion of participants experiencing a specific emotion. Then, voxel-wise encoding was performed using a multiple linear regression approach to measure the association between brain activity and emotion ratings. Resulting p-values were corrected for multiple comparisons (pbonf<0.05) to obtain single-subject maps of brain regions significantly encoding affective experience. Single-subject maps were then combined into a probabilistic map. Results. Behavioral ratings across the audio-visual and the audio-only modalities were highly correlated over time, with a spearmanâ€™s rho of 0.76 (p<0.01). Considering the probabilistic map, we found that ventromedial prefrontal cortex (vmPFC) was significantly associated to the affective ratings in at least half of the subjects, consistently across different groups (i.e., sighted and blinds) and modalities (i.e., audio-visual and audio-only in sighted). Discussion and Conclusions. Altogether, these findings in sighted and congenitally bilnd individuals indicate that affective experiences are encoded in vmPFC

regardless of the sensory modality and independently from visual experience. These results extend to affective processing in vmPFC, the supramodal brain organization for perception, motor representation and action planning.

High-definition transcranial direct current stimulation of the dorsal anterior cingulate cortex modulates decision-making and executive control

Giulia Mattavelli, S. Lo Presti, D. Tornaghi, N. Canessa

Abstract

Objective. The dorsal anterior cingulate cortex (dACC) is a key node of the networks underlying conflict monitoring and decision-making. Indeed, previous neuroimaging evidence highlights the translational implications of targeting this region in brain stimulation treatments with clinical or rehabilitative purposes. While the optimized modelling of â€œhigh-definitionâ€• current flows between multiple anode-cathode pairs might, in principle, allow to stimulate an otherwise challenging target, sensitive benchmark metrics of dACC neuromodulation are required to assess the effectiveness of this approach. In the present study we aimed to assess the modulatory effect of anodal and cathodal high-definition tDCS (HD-tDCS) of the dACC on different facets of executive control and decision-making in healthy young individuals. Materials and Methods. A combined modelling/targeting procedure provided the optimal montage for the maximum intensity of dACC stimulation with 6 small â€œhigh definitionâ€• electrodes delivering anodal, cathodal or sham HD-tDCS for 20 minutes in a within-subject design with three separate sessions. Following stimulation, participants performed Flanker and gambling tasks unveiling individual differences in executive control and both loss- and risk-aversion in decision-making, respectively. Results. Compared with both anodal and sham conditions, cathodal dACC stimulation significantly affected task performance by increasing control over the Flanker conflict effect, and both loss- and risk-aversion in decision-making. Discussion. This pattern of findings provides novel evidence on the dACC role in energizing multiple facets of executive control, from conflict detection and resolution to decision-making. The polarity-dependent effect of cathodal stimulation, which increased executive control, complements previous reports of improved behavioral performance after cathodal tDCS, possibly acting as a noise filter for irrelevant stimuli, or levelling out the activity of competitive activation patterns elicited by perceptually complex tasks. Conclusion. By confirming the feasibility and effectiveness of dACC stimulation with HD-tDCS, these findings highlight the implications of modelling and targeting procedures for neuromodulation in clinical research, whereby innovative protocols might serve as standalone treatment, or combined with cognitive training, to enhance higher-order executive functioning in different neuro-psychiatric conditions.

Decision signals in the intraparietal sulcus during item recognition revealed by MEG recording of alpha rhythm modulations

Carlo Sestieri, S. Spadone, A. Tosoni, S. Della Penna

Abstract

Aims: One hypothesis about the role of the lateral posterior parietal cortex during the retrieval of episodic memories posits that regions along the intraparietal sulcus might work as a mnemonic accumulator of evidence for memory-based decisions. However, the hypothesis is based almost exclusively on the analysis of the BOLD evoked response, which has poor temporal resolution and reflects the sum of hemodynamic activity related to multiple processes. The present study tested the hypothesis that oscillatory activity within the IPS, recorded through magnetoencephalography (MEG), reflects decision-related signals during memory retrieval. Methods: A group of 22 healthy, right-handed subjects participated in the study, which involved two sessions (encoding, retrieval). At encoding, subjects performed an incidental indoor/outdoor judgment on visually presented images depicting scenes from different categories. At retrieval, we used MEG and an item recognition paradigm that involved the manipulation of evidence favoring old (i.e. variation of encoding strength) vs. new (variation of similarity with old images) choices. Results: We used a

data-driven approach to identify brain nodes exhibiting both a retrieval success effect and a variation of oscillatory activity in response to the amount of evidence for old decisions. Two regions in the left parietal cortex exhibited an alpha ERD that started ~400ms after stimulus onset and showed both modulations. Further analyses showed that alpha ERD in the intraparietal sulcus, but not in the angular gyrus: i. was sensitive to the amount of decision evidence also for new decisions, ii. was relevant for behavior, as demonstrated by between-subject correlations, and iii. better tracked the subjective memory judgment rather than the recovery of information about the item. Discussion: The present study identified a region of the intraparietal sulcus showing a selective modulation of the alpha ERD consistent with the representation of a decision variable during memory retrieval. The spatial and functional specificity of the present findings provide support for a recent anatomical-functional model of the parietal involvement in episodic memory retrieval and suggest that the alpha ERD might be a neural signature of evidence accumulation during memory-based decisions.

SABATO 2 OTTOBRE 2021

COMUNICAZIONI ORALI

The persistence of the placebo effect after disclosure during a motor task

Diletta Barbiani, M. Emadi Andani, M. Bonetto, B. Villa-Sanchez, M. Fiorio

Abstract

Despite placebos often require deception to elicit an effect, mounting evidence suggests that the administration of placebos along with truthful information about their nature (i.e., open-label placebos) does not wear off their effectiveness. The aim of the present study is to explore whether the disclosure of a placebo manipulation during a leg-extension exercise differentially impacts behavioral and subjective parameters in healthy, non- athlete individuals, as compared to a classic placebo procedure or control. The motor task consisted in a single-right leg extension to be performed at the maximum force across four sessions, each comprising of ten trials. Transcutaneous electrical nerve stimulation (TENS) was applied for four minutes in-between sessions in an inert fashion and served as the placebo device to instill neutral or positive expectations on force production. Sixty healthy volunteers were subdivided into three groups. A control group (Control) did not undergo any manipulation and received information that TENS would be applied at inert frequencies throughout all experimental sessions. A placebo group (Placebo) was deceptively informed that TENS would be effective in enhancing participantsâ€™ level of force, thus improving task performance. A second placebo group (Placebo-overt) received the same information of the placebo group, with the only difference that prior to the final session, participants were made aware of the placebo manipulation, along with an explanation on the neuroscientific meaning of placebos and on their proven effectiveness albeit being devoid of intrinsic therapeutic properties. In session four, both Placebo ($p = 0.003$, $d = 1.17$) and Placebo-overt ($p = 0.003$, $d = 1.25$) showed significantly higher levels of force compared to Control, while no difference in force was found between Placebo and Placebo-overt across sessions ($p > 0.763$). Moreover, Placebo ($p > 0.114$) and Placebo-overt ($p = 0.519$) did not show a significant drop in force throughout sessions, which instead was present in Control ($p < 0.003$, $d > 1.42$). Importantly, task-specific self-efficacy scores did not differ between placebo groups, even after revealing the placebo manipulation in the Placebo-overt group. These findings demonstrate that even when placebos are disclosed as such, their effects may be comparable to those elicited by a classic placebo procedure that is fraught with deception. This may have important implications in terms of an ethical usage of placebos in motor contexts to boost self-efficacy and improve treatment outcome. References: Colloca, L., Schafer, S.M. & Wager, T.D. (2015) Conditioned Placebo Analgesia Persists When Subjects Know. The journal of pain, 16(5), 412-420. Aljamal, Y., Prabhakar, N., Saleem, H. & Farley, D. R. (2019) Can the Perceived

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Let's play MindTheCity!: a virtual navigational 3D-videogame for enhancing spatial memory

Elena Del Fante, D. Vadda, I. Ronga, A. Ghiggia, G. Geminiani, K. Sacco

Abstract

New technologies, including videogames trainings, represent a great opportunity for the study and rehabilitation of cognitive functions, offering the possibility of developing environments that could hardly be created in real life. Objective: The study represents a preliminary validation of a rehabilitative game-based protocol (MindTheCity!), aiming to train spatial memory, which is often affected during the cognitive decline associated with age. Materials and Methods: We developed a navigational videogame (MindTheCity! â€“ a virtual town) matched with an Object-Location-Test, employed to train, and assessed memory performance (graphic and 3D development: SynArea Consultants). We recruited 20 healthy elders (mean age: 65,15; SD Â±4,332). The experiment was composed of a training phase, a control phase (both consisting of 20 sessions of 20 minutes each), and an assessment. During the training, participants were asked to play MindTheCity! whereas for the control, participants were asked to passively observed some videos of an avatar navigating MindTheCity!. The training consisted of two phases: (1) â€œFree Navigationâ€•, in which each subject explored 5 districts of MindTheCity! in search of some components to build a bicycle; (2) â€œObject Searchâ€•, in which they were asked to recollect the previously found parts of the bicycle. Following each object collection, the subject was required to perform a pointing-task, indicating the location of the previously found object. This was done to further assess participantsâ€™ orientation performance. Participantsâ€™ angular errors were collected. Before and after training and control, participants performed the Object-Location-Test, consisting in the memorization and recall of the spatial location of 16 objects in a grid (5 repetition for each assessment). Results: Mean angular errors performed in the second half of training were significantly lower than those occurred in the first half of training (First Half: mean 683.352; SDÂ± 439.925; Second Half: mean 438.481 SDÂ± 333.09; t19: 6,156; p-value: < .001). Results at the Object-Location-Test revealed that memorization performances were significantly enhanced following MindTheCity! training compared to pre-training (Pre-training: mean 46.85; SDÂ± 21.151; Post-training: mean: 52.5; SDÂ± 23.836; T19: -3.189; P-value: 0.004) and compared to post-control (Post-control: mean: 45.4; SDÂ± 23.836; t19: 2.321; p-value: 0.03) while no significantly improvement was observed after control condition (Pre-control: mean 47.5; SDÂ± 17.727; T19: 1.176; P-value: 0.254). Discussion: Subjectsâ€™ spatial memory performance resulted improved at the end of the training, thus suggesting that MindTheCity! training improves the ability to build and remember the spatial relationships between different elements, independently from participantsâ€™ position in space. References: Amadeo, M. B., Schinello, M., Caglio, M., Geminiani, G. C., & Sacco, K. Training di navigazione spaziale in ambienti di realtÃ virtuale: Uno studio pilota di risonanza magnetica su partecipanti sani. Sistemi Intelligenti, 2018, 30(1), 107â€“122. Caglio, M., Latini-Corazzini, L., Dâ€™Agata, F., Cauda, F., Sacco, K., Monteverdi, S., Geminiani, G. Virtual navigation for memory rehabilitation in a traumatic brain injured patient. Neurocase, 2012, 18, 123â€“131. Spence, I., & Feng, J. Video Games and Spatial Cognition. Review of General Psychology, 2010, 14(2), 92â€“104.

Boosting social prediction abilities with cerebellar stimulation: evidence from tDCS studies in healthy adults and in patients with cerebellar malformation

Alessandra Finisguerra, V. Oldrati, N. Butti, E. Ferrari, C. Urgesi

Abstract

The cerebellum is involved in generating and updating the internal models subserving the prediction of sensory events. Indeed, congenital or acquired cerebellum alteration are associated not only with motor, or cognitive disorders but also with difficulties in social perception1,2. However, the rehabilitation of social abilities is often neglected. We aimed to test the effects of cerebellar transcranial Direct Current Stimulation ctDCS on the prediction of social and physical events in healthy adults3 and in adolescents and young adults with cerebellar malformation. We applied anodic, cathodic and sham ctDCS to modulate the performance of healthy adults in two tasks requiring the prediction of social actions or moving shapes. For both tasks, in an earlier implicit-learning phase (familiarization), we manipulated the probability of co-occurrence between a particular action/shape and contextual elements, which could provide either strongly or moderately informative expectations. The use of these expectations was then assessed in a testing phase, when participants had to predict the unfolding of temporally occluded videos, in situations of perceptual uncertainty. Moreover, in a sample of young adults and adolescents with paediatric ataxia, we applied anodic and sham ctDCS during the execution of the task requiring the prediction of social events. Results of the ctDCS study in healthy adults showed that in the testing, but not in the familiarization phase, cathodic as compared to anodic and sham ctDCS hindered participants' sensitivity in predicting actions embedded in strongly, but not moderately, informative contexts. Conversely, anodic as compared to sham ctDCS boosted the prediction of actions embedded in moderately, but not strongly, informative contexts. We observed no ctDCS effects for the shape prediction task, thus pointing to a specific involvement of the cerebellum in forming expectations related to social events. Preliminary results of the ctDCS study in patients with paediatric ataxia suggest an improvement in social prediction abilities after anodic ctDCS. Overall these findings encourage the exploration of rehabilitative effects of ctDCS in patients with social perception deficits and the use of non invasive brain stimulation in children and adolescent with neurological and neurodevelopmental disorders. References: 1Butti, Corti, Finisguerra, Bardoni, Borgatti, Poggi, & Urgesi, (2020). Cerebellar Damage Affects Contextual Priors for Action Prediction in Patients with Childhood Brain Tumor. Cerebellum, 19(6), 799â€“811. 2Urgesi, Butti et al., under review; 3Oldrati, Ferrari, Butti, Cattaneo, Borgatti, Urgesi, & Finisguerra, (2021). How social is the cerebellum? Exploring the effects of cerebellar transcranial direct current stimulation on the prediction of social and physical events. Brain Structure and Function, 226(3), 671â€“684.

Effect of multisensorial immersive stimulation (MImE) in disorders of consciousness

Luca Padua, G. Fredda, G. Reale, D. Coraci, L. Castelli, C. Loreti, S. Giovannini, R. Bernabei

Abstract

Objective. Rehabilitation approach for disorders of consciousness (DoC) includes sensorial stimulation, pharmacological treatments and both invasive and non-invasive brain stimulation. Our hypothesis is that a multisensorial immersive experience (MImE) may enhance DoC recovery by simultaneously stimulating many different brain areas. Aim of this study is to evaluate whether: 1) MImE modifies arousal and awareness of DoC patients; 2) MImE modulates autonomic nervous system function. Materials. We enrolled 14 consecutive DoC patients, all naÃ¯ve to specific DoC rehabilitation treatments. All patients underwent to a 5-days MImE session. MImE consisted of: a) a high definition video projected on a three-wall screen; b) a high definition audio delivered via two speakers and a subwoofer. Arousal and awareness modifications were evaluated via a neurobehavioral changes form (recording eye opening, visual pursuit and fixation, movements, vocalizations, command following. Audiovisual content lasted 5 minutes, presenting landscapes and relaxing music. Autonomic Nervous System activity was evaluated through electrodermal activity (EDA) recorded with E4, EmpaticA. Methods. We evaluated patients at three time-points: a) baseline; b) treatment response; c) post-treatment phase. Evaluation consisted of: neurobehavioral changes; EDA activity 10 minutes before, during and after MImE. Results. During the five sessions, we observed a progressive increase of the number of patients that at the baseline were already wakeful. In particular, 5 patients were wakeful at baseline in the first session, 5 in the second, 6 in the third, 9 in the fourth and 10 in the fifth. During the first MImE session, EDA had a significant increase. The EDA

increase was significant not only among wakeful patients, but also among non-wakeful patients. After the second MImE session, the EDA modifications in the two groups were very similar. Discussion. MImE can positively impact on DoC patientsâ€™ wakefulness. Not only we observed wakefulness modifications during the MImE, but also the aforementioned changes seemed to remain stable over time. It must be noticed that all the changes we observed were towards better wakefulness states (from non-wakeful to wakeful, from unresponsive to responsive), without any worsening, suggesting at least a enhancing effect of MImE on DoC recovery. Finally, we detected interesting autonomic nervous system changes, even in non-wakeful patients. This autonomic nervous system might be an epiphenomenon of the widespread brain activation enhanced by the Pag. 1 Effect of multisensorial immersive stimulation (MImE) in disorders of consciousness simultaneous and immersive sensorial stimulation. Conclusions. MImE appears to significantly promote consciousness recovery and to modulate the autonomic nervous system function. References: Padua L, Cuccagna C, Pazzaglia C. Novel sensory paradigms for neuromodulation in disorders of consciousness in traumatic brain injury. Curr Opin Neurol. 2019 Dec;32(6):844-849 Cheng L, Cortese D, Monti MM, Wang F, Riganello F, Arcuri F, Di H, Schnakers C. Do Sensory Stimulation Programs Have an Impact on Consciousness Recovery? Front Neurol. 2018 Oct 2;9:826 LuautÃ© J, Dubois A, Heine L, Guironnet C, Juliat A, Gaveau V, Tillmann B, Perrin F. Electrodermal reactivity to emotional stimuli in healthy subjects and patients with disorders of consciousness. Ann Phys Rehabil Med. 2018 Nov;61(6):401-406.

Seeing ain't believing

Corrado Sinigaglia, G. Riva

Abstract

Reading other minds is a pervasive feature of human social life. A decade of research indicates that people automatically track othersâ€™ beliefs even when is not required (KovÃ¡cs et al., 2010; van der Wel et al., 2014; Schneider et al., 2017). Yet it is currently far from clear what this automatic mindreading really is. While some invoke a non-mentalistic account, others appeal to a core system enabling both automatic and non-automatic mindreading. More recently, a two- system account has been proposed, where non-automatic (but not automatic) mindreading involves representing othersâ€™ beliefs as beliefs. The present study aimed to assess whether automatic mindreading involves any kind of mental state ascription by systematically investigating how an agentâ€™s information access and action possibilities influence participantsâ€™ belief tracking. To this end, we ran six Experiments, in which participants (n=20 for each Experiment, for a total of n=120) had to perform a belief-tracking task which was either uninstructed (Experiments 1, 3, and 5) or instructed (Experiments 2, 4, and 6). The task required to watch a movie which started with a character (a smurf) placing a ball in front of an occluder and the ball rolling behind it, staying there or moving away. While in the Experiments 1-2, the smurf could see the rolling ball, in the Experiments 3-4 the smurf turned his back to the ball, being thus unable to see all its movement. Finally, in Experiments 5-6, the smurf appeared immobilized within a Plexiglas cage and looked at the ball rolling behind the occluder, staying there or moving away. Our results showed that, unlike non-automatic mindreading, automatic mindreading does not involve explicitly knowing what others believe. Further, while non-automatic mindreading relies on the principle seeing is believing, in automatic mindreading seeing is neither necessary nor sufficient for believing. In automatic mindreading, believing instead hinges on what another agent could (or could not) do. It is therefore time to consider reframing what mindreading really is. References: KovÃ¡cs, A.M., TÃ©glÃ¡s, E., Endress, A.D. (2010). The social sense: Susceptibility to othersâ€™ beliefs in human infants and adults. Science 330, 1830â€“1834. van der Wel, R.P.R.D., Sebanz, N., Knoblich, G. (2014). Do people automatically track othersâ€™ beliefs? Evidence from a continuous measure. Cognition 130, 128â€“133. Schneider, D. Slaughter, V.P. Dux, P.E. (2017). Current evidence for automatic Theory of Mind processing in adults. Cognition 162, 27â€“31.

GIOVEDI' 30 SETTEMBRE 2021

POSTER

Control of core temperature in major orthopedic surgery and neurotraumatology using Levobupivacaine for spinal anesthesia in old patients with delirium using Donezepil

Barbara Amarisse, C. Renzini, A. Zurlo, G. Giuliani

Abstract

In major orthopaedic surgery in geriatric patients (N=25) aged between 75Â±85 with intraoperative heating, the incidence of overall delirium is 15%; delirium with a single event in the controls during the stay 40%; severe delirium 5%; delirium in the postoperative stage 15%; delirium on discharge 5%; delirium in the control stage after discharge 4%. In major orthopaedic surgery in geriatric patients (N=25) aged between 75Â±85 without intraoperative heating, the incidence of overall delirium is 32%; delirium with a single event of delirium in the controls during the stay 50%; severe delirium 12%; delirium in the postoperative stage 29%; delirium on discharge 13%; delirium in the control stage after discharge 19%. Pharmacological treatment of delirium: with intraoperative heating donezepil 5 1 pill day, Haloperidol 8 drops; without intraoperative heating donezepil 10 1 pill once/day and Haloperidol 1dose i.m.; without intraoperative heating with mini nutritional assessment low olanzapine 1 pill once/day, donezepil 10 1 pill once/day, Haloperidol 1 dose i.m. In the 50 patients before the operation, the mini nutritional assessment is 23Â±24, on discharge in group A with intraoperative heating the mini nutritional assessment is 21Â±20; in group B without intraoperative heating, the mini nutritional assessment is 19Â±18. Mini mental test preoperative score in geristric patients (N=50 pt) undergoing major surgery is 18. Mini mental test postoperative score in geriatric patients group A is 10. Mini mental test postoperative score in geriatric patients group B is 5 References: Sessler DI Current Concepts: Mild Perioperative Hypotermia. N Engl J Med; 336: 1730-7 Control of core temperature in major orthopaedic surgery and neuro-traumatology using levobupivacaine for spinal anaesthesia,B. Amarisse, V.A. Peduto (University of Perugia) Neurological Sciences Volume 40-October 2019 Congress of the Italian Neurological Society ABSTRACT s 132 vol. 40 Congress of the Italian Neurological Society POSTERS n. 761,762 pg. 232-October 2019 Control of core temperature in major orthopaedic surgery and neuro-traumatology using levobupivacaine for spinal anaesthesia in old patiens,B. Amarisse, V.A. Peduto (University of Perugia) Neurological Sciences Volume 40-October 2019 Congress of the Italian Neurological Society ABSTRACT s 477 vol. 40 Congress of the Italian Neurolological Society ORAL COMMUNICATION October 2019.

Functional features of the Bereitschaftspotential: a TMS-EEG study on cortical excitability and connectivity of the Supplementary Motor Area (SMA) in Go/No-go tasks

Eleonora Arrigoni, V. Bianco, F. Di Russo, L. Romero Lauro, A. Pisoni

Abstract

The Bereitschaftspotential (BP) is a slow ERP associated with motor preparation, starting 1-3s before movement onset, peaking on central scalp electrodes1 and originating in the left SMA. The brain network underlying BP time course is still unclear. Possibly, a different organization within the premotor or parietal regions in the EEG beta and gamma bands functional networks occurs (Kim et al., 2017), but conclusive evidence is missing. Recently, TMS-EEG integrated systems have been used to probe connectivity changes among different cognitive states (Shibasaki H, & Hallett M, 2006), allowing to measure cortical excitability and functional connectivity of a target region (Pisoni et al., 2018). Here, we recorded TMS evoked-potentials (TEP) stimulating the left-SMA before the onset of stimuli requiring motor responses in order to assess whether and how cortical excitability and functional connectivity of this region change as the BP increases. Fourteen subjects were tested in a visual go/no-go task, delivering TMS over the left-SMA or left extrastriate region as control. Single TMS pulse was applied -700ms and -300ms from image onset, targeting the early and late BP stages, respectively, while TEPs were recorded from 60 scalp electrodes.

TEPs amplitude were compared within-stimulation sites between the two SOAs with a cluster-based permutation approach. Moreover, functional connectivity was obtained from source reconstruction by computing the Phase-Locking Value (PLV) between the left-SMA and the other brain parcels for alpha (8-12 Hz), beta (13-30 Hz), gamma (31-40 Hz) bands for the two TMS SOAs. The SMA cortical excitability increased with the BP evolution, as a greater response was found delivering TMS during the late BP phase (i.e. -300ms). Connectivity analysis showed larger gamma and alpha-band connectivity between SMA and other motor-related cortical and subcortical regions, in the late compared to the early BP phase, thus indicating a gradual specialization of the activity of the SMA in building a voluntary motor act. Conversely, during the time-course of motor preparation, SMA-related beta-band connectivity was maintained constant between the two SOAs, possibly suggesting a sustained, top-down attentional control, involved in the preparatory stage of the task. These findings suggest that the BP is not a mere result of an increased activation of the SMA, but it reflects a qualitative change of the functional networks in which this region is involved over time, becoming progressively more related to the execution of the motor act. References: Shibasaki, Hiroshi, and Mark Hallett. "What is the Bereitschaftspotential?." Clinical neurophysiology 117.11 (2006): 2341-2356. Kim, Kisun, June Sic Kim, and Chun Kee Chung. "Increased gamma connectivity in the human prefrontal cortex during the bereitschaftspotential." Frontiers in human neuroscience 11 (2017): 180. Pisoni, Alberto, et al. "Cortical dynamics underpinning the self-other distinction of touch: A TMS-EEG study." NeuroImage 178 (2018): 475-484.

ApoE4 with isolated Aβ pathology results in less aggressive Alzheimer's disease

Martina Assogna, C. Motta, S. Bonnì, I. Borghi, E. Casula, A. Martorana, G. Koch

Abstract

The recent NIA-AA classification moved towards a new definition of Alzheimerâ€™s disease (AD), shifting from a clinical to a biological construct, documented by cerebrospinal fluid (CSF) biomarkers and imaging. Here we aimed at investigating how disruption of LTP like-cortical plasticity and cholinergic neurotransmission deficits may vary according to the NIA-AA criteria and the APOE genotype. 65 patients with probable or possible AD were enrolled. APOE genotype and lumbar puncture for the analysis of CSF biomarkers were performed for diagnostic purposes. Patients were subdivided upon NIA-AA criteria, according to the presence of in vivo biomarkers of AÎ² amyloid deposition (A) and fibrillar tau (T). We applied intermittent theta burst stimulation protocol over M1 to assess LTP-like cortical plasticity and short latency afferent inhibition (SAI) protocol to investigate central cholinergic activity. Patients were followed over 24 months. Cognitive decline was evaluated considering changes in Mini Mental Status Examination scores respect to the baseline. A+/T-E4 patients showed preserved LTP-like cortical plasticity as compared to A+/T- E3 and to A+/T+ patients independently from genotype. In addition, A+/T- E4 patients showed a slower cognitive decline with respect to A+/T+E4 and to A+/T+E3 patients. No differences were found for SAI protocol. AD patients with isolated amyloid pathology and APOE4 genotype are characterized by a less aggressive form of disease. Our work provided new evidence on interactions among AÎ² amyloid, tau proteins deposition and APOE genotype, suggesting a framework in which multiple pathological mechanisms act synergistically to determine disease progression along the AD continuum.

Age-dependent effects of tDCS on episodic memory

Chiara Bagattini, S. Cid-Fernandez, M. Bulgari, C. Miniussi, M. Bortoletto

Abstract

OBJECTIVES Episodic memory (EM) remains relatively stable until the age of 60-65. Afterwards, an accelerated decline is generally observed. Transcranial direct current stimulation (tDCS) has gained attention as a potential tool to retain age-related memory decline. Considering the physiological changes and the increased inter-individual variability that aging brings along, elderly cannot be considered a homogeneous population. In order to delineate variability in the response to tDCS throughout the aging

lifespan, the present study aimed to investigate 1) whether tDCS differently modulates EM at different stages of healthy aging (namely, before and after 65 years-old); 2) how tDCS modulation affects the neural mechanisms underlying EM. MATERIALS 19 middle-aged (â‰¤64 years-old; mean age 57.11; min-max 50-64) and 19 older (â‰¥ 65; mean age 71.63; min-max 65-81) healthy adults participated in the present study. We used a within-subjects design to compare behavioral performance and event related potential (ERP) elicited by picture recognition task after tDCS over the left DLPFC in the two age groups. METHODS All subjects underwent two identical experimental sessions, except for the tDCS delivered (anodal or sham) during a picture-encoding task. Behavioral and ERP measures were collected during the delayed recognition phase. Repeated measures ANCOVA with group (middle-aged, older), type of stimulation (anodal, sham) and education as covariate were computed to analyze behavioral (hit rate) and ERP mean amplitude (early frontal, parietal and late frontal old/new effects) measures. RESULTS Behavioral results showed a significant interaction between group and type of stimulation (F=7.514; p=0.010), with middle-aged and older adults showing an opposite effect. Anodal tDCS induced a reduction in the number of correctly recognized pictures in middle-aged participants (p=0.048), but increased the recognition performance in the older (p=0.043). Regarding the old/new EM effects, ERPs results showed that in the middle-aged group anodal tDCS reduced early (p=0.034) and late frontal (p=0.019) effects amplitude. DISCUSSION The present results showed age-related differential effects of anodal tDCS in EM modulation. Whereas tDCS enhanced memory performance in older adults, it induced a detrimental effect in middle-aged participants. The behavioral worsening observed in the middle-aged group was mirrored with an amplitude reduction of the neural EM correlates. CONCLUSIONS These findings are consistent with the observation that tDCS effects might be beneficial only above a certain level of functional loss, and highlight the importance of moving toward an individualized use of brain stimulation techniques. Considering the factors that determine responsiveness to tDCS may prevent null or even detrimental effects.

Target selection, but not distractor suppression, is impaired by single pulse TMS over right Frontal Eye Field

Eleonora Baldini, M. Marangon, S. Mele, C. Lega, C. Dolci, E. Santandrea, L. Chelazzi

Abstract

The ability to suppress irrelevant but attention-grabbing information while executing a task, such as driving or playing videogames, is a cardinal function of the frontoparietal dorsal attention network that underlies goal-directed control in human behaviour. In a recent study [1], transcranial magnetic stimulation (TMS) has been used to highlight a distinct hemispheric contribution of the right versus left dorsal frontoparietal cortex to distraction filtering, specifically involving the frontal eye field (FEF) and/or the intraparietal sulcus (IPS). The results showed that, when a distracting stimulus is detected, repetitive TMS delivered over right (but not left) FEF, and not over IPS on either side of the brain, enhances distractor filtering. Here, to further scrutinize the role played by the right FEF in distraction filtering, we sought to investigate the temporal contribution of this critical node belonging to the frontoparietal dorsal attention network, as also suggested by functional magnetic resonance imaging (fMRI) studies [2, 3]. Specifically, in healthy participants, we used single pulse TMS (spTMS) to transiently interfere with the function of right FEF at 3 different time points (0, 100, 250 ms after array onset) during the execution of a visual search task. Participants were required to identify a target within a four-item array; on half of the trials, the array also included a salient color distractor in order to effectively grab their attention, thus slowing target search within the array. We compared the participantsâ€™ performance, measured by response times (RTs), between a stimulation-over-right-FEF condition and a control (sham) condition. Quite surprisingly, the results did not reveal a variable effect for the different time points. Crucially, stimulation of the right FEF significantly prolonged RTs compared to a control (sham) condition, but only when the target was located in the hemifield contralateral to the active stimulation site, Further, we detected a numerical trend for targets located in the ipsilateral hemifield, but this effect was much weaker. Moreover, right FEF stimulation did not produce any effect over the cost engendered by the salient distractor, irrespective of both target and distractor

location. These findings indicate that the right FEF plays a critical role in orienting to - and selection of - the target stimulus, especially for the hemifield contralateral to the stimulation site. Further research is needed in order to decipher the precise role of the right (and left) FEF in target selection and distractor filtering. References: Lega C, Ferrante O, Marini F, Santandrea E, Cattaneo L and Chelazzi L. (2019). Probing the Neural Mechanisms for Distractor Filtering and Their History-Contingent Modulation by Means of TMS. Journal of Neuroscience 18 September 2019, 39 (38) 7591-7603 Marini F, Demeter E, Roberts KC, Chelazzi L, Woldorff MG (2016). Orchestrating Proactive and Reactive Mechanisms for Filtering Distracting Information: Brain-Behavior Relationships Revealed by a Mixed-Design fMRI Study.J Neurosci. Jan 20; 36(3):988-1000 Cosman JD, Lowe KA, Zinke W, Woodman GF, Schall JD. (2018). Prefrontal Control of Visual Distraction. Curr Biol. Feb 5; 28(3):414-420.e3.

Turn up the volume: aesthetic experience elicited by music shifts the attentional balance from internal to external stimuli

Paolo Barbieri, P. Sarasso, L. Bechis, M. Neppi-Modona, K. Sacco, I. Ronga

Abstract

Recent developments in neuroaesthetics highlighted the relationship between the perception of beauty and knowledge acquisition. More specifically, it has been suggested that when the experience of beauty is expected, individuals might experience a transitory top-down effect on perceptual sensitivity, boosting attention and the perceptual learning of subsequent environmental stimuli at the expense of self-oriented attention (i.e., aesthetic attitude). However, this theoretical hypothesis has never been empirically tested. The present study (composed of an EEG and a behavioural experiment) investigates the influence of aesthetic experience on the attentional balance between internal (inward-orienting attention) and external states (outward-orienting attention), with a special focus on learning dynamics. We employed musical stimuli (5 minutes musical pieces) to manipulate the aesthetic attentional attitude of the participants, who were asked to listen passively and rate the beauty of the pieces. Following music listening, they underwent to an implicit learning task while the brain activity was recorded with the EEG (Experiment 1). An auditory roving paradigm with frequency (Hz) deviant and standard sounds was employed to compute mismatch negativity responses (MMN), a well-validated index of perceptual learning able to reflect outward attention. In Experiment 2, directed to explore attention toward internal states, we measured heartbeat detection (HBD) accuracies following music listening. Results show that while MMN responses were significantly larger after listening to subjectively more appreciated musical stimuli, HBD accuracies were significantly lower following preferred music. The improved performance in the implicit learning task (Experiment 1) demonstrated that participants were more attuned to their sensory environment following most appreciated musical pieces. On the other hand, the lower accuracy in the HBD task seems to indicate that the sensitivity to internal states is reduced following more aesthetical appreciated music. Our data might therefore be considered as a supporting empirical evidence to the aesthetic attitude hypothesis, showing that aesthetic experience could enhance the attentional resources toward external stimuli at the expense of self-referred attention. Future studies should be directed to assess whether the attentional boost directed towards environmental stimuli induced by aesthetic appreciation might be exploited for possible clinical applications, both for cognitive enhancement or for the treatment of psychological disorders, such as anxiety. References: Sarasso, P., Neppi-Modona, M., Sacco K., & Ronga I.. Stopping for knowledge: the sense of beauty in the perception-action cycle. Neuroscience and Biobehavioural Reviews, (2020), 118, 723â€“738. https:// doi.org/10.1016/j.neubiorev.2020.09.004 Sarasso, P., Perna, P., Barbieri, Neppi-Modona, M., Sacco, K., Ronga, I. Memorisation and implicit perceptual learning are enhanced for preferred musical intervals and chords. Psychonomic Bulletin & Review (2021). https://doi.org/10.3758/s13423-021-01922-z Brattico, E., & VarankaitÄ—, U. Aesthetic empowerment through music. Musicae Scientiae (2019). 23, 285â€“303. https://doi.org/10.1177/1029864919850606

On the network specificity of the TMS-evoked potentials

Giacomo Bertazzoli, E. Canu, D. Calderaro, C. Bagattini, F. Agosta, C. Fracassi, M. Marizzoni, V. Nicolosi, M. Filippi, M. Bortoletto

Abstract

Concurrent transcranial magnetic stimulation and electroencephalography (TMS-EEG) is an emerging tool to study brain connectivity in which the spread of the signal through the cortex that follows a TMS pulse can be tracked with millisecond precision of the EEG. Such a measure, called TMS-evoked potential (TEP), when measured after the stimulation of a brain networkâ€™s node, should represent the spread of the signal over time in that specific network. Here, we aim to test the specificity of the TEP to the stimulated network, i.e., if and how the TEPs resemble each other when targeting different brain networks with the TMS. To test this aim, we stimulated the left-right parietal nodes of the default-mode network (DMN) and the left-right dorsolateral prefrontal nodes of the executive control network (ECN). The nodes were defined at the single-subject level, using an independent component analysis with 80 single TMS pulses on 28 healthy participants. As a control condition, the same stimulation protocol was applied on the vertex (Cz), with a 3 cm spacer between the coil and the scalp, to avoid direct stimulation of the cortex. TEPs extracted from these five conditions (L-DMN, R-DMN, L-ECN, R-ECN and sham) where processed and a Spearman correlation analysis was performed in both space and time dimensions. Spatial correlation, i.e., the instantaneous correlation across channels between two conditions, revealed a poor correlation right after the TMS pulse, with a steady increase that peaked at 100 ms (0.4<RHO<0.7) for all condition. After 100 ms, all the correlations with the sham condition dropped below a RHO of 0.4, while the other comparisons peaked again around 200 ms (0.5<RHO<0.7). Similarly, the temporal correlation, i.e., the channel-by-channel correlation across segments of the signal between two conditions, reveled a general trend of high correlation between real-stimulation conditions and a poor correlation between real-stimulation and sham. Interestingly, the comparisons that showed the highest correlation value were the one between the same network stimulation i.e. L-R DMN and L-R ECN, with respectively 0.5<RHO<0.7 and 0.6<RHO<0.8 on central electrodes. These results suggest that the TEPs originated from the stimulation of different networks are not stereotypical in the first 100 ms, while they become more similar towards late latencies. This might be due to the fact that the initial response of a TMS pulse may reflect a network-specific activation, while late responses represent the activation of associative areas which happen independently of the network activated. References: Bortoletto, M., Veniero, D., Thut, G., & Miniussi, C. (2015). The contribution of TMS-EEG coregistration in the exploration of the human cortical connectome. Neuroscience & Biobehavioral Reviews, 49, 114-124.

Cardiac autonomic signature of learned fear in humans

Simone Battaglia, S. Orsolini, S. Borgomaneri, R. Barbieri, S. Diciotti, G. di Pellegrino

Abstract

Aims. Understanding transient dynamics of autonomic control during emotional learning is crucial to translate basic research into the treatment of psychopathology. It has been widely observed that fear learning typically elicits short-latency bradycardia in humans. However, standard analyses of heart rate variability (HRV) fail to disentangle the contribution of parasympathetic and sympathetic activation and to capture phasic changes of HRV during fear learning. Materials. In the present study, participants underwent a fear conditioning procedure in which a stimulus (CS+) was probabilistically paired with an electric shock (US), while a different stimulus (CSâˆ’) was never paired with the US. Fear acquisition was followed by an extinction phase during which both CSs were presented in the absence of the US. Here, to describe transient patterns in autonomic activity, we examined instantaneous spectral estimates of HRV using a point-process modelling algorithm. Method. To this aim, 50 healthy participants (mean age = 24 years) underwent a fear conditioning and extinction protocol. Two novel approaches were used to perform a frequency-domain analysis of HRV: short-time Fourier transform and instantaneous spectral estimation.

Specifically, we tested whether the spectral components of the HRV, used as a non-invasive biomarker of sympathetic and parasympathetic activity, are able to distinguish between fear conditioned and neutral stimuli. Results. We found that learned fear elicited a profound heart rate deceleration in anticipation of noxious stimuli. More importantly, results revealed significant increases in spectral power in the High-Frequency (0.15â€“0.40 Hz) band, indicating a specific vagal contribution, which robustly and reliably distinguished conditioned from neutral stimuli during fear learning. Discussion. Taken together these results indicate that the presentation of CS+, as compared to CS-, elicits a strong response in the High-Frequency range, sustaining specific vagal contribution, thus explained bradycardia induced in response to fear conditioned stimulus. Importantly, this implies that fear conditioned stimulus has been able to trigger vagal branches, slowing the heartbeats, as revealed by the spectral analysis showing a significant cluster within the frequency band of vagal contribution. Conclusion. These results provide unique evidence of the direct involvement of the parasympathetic (vagal) component of the autonomic nervous system during fear learning. These laboratory findings can be readily translated into the clinical field, thereby providing a novel and accessible tool to evaluate several psychopathological processes, and quantify deficits of Vagus nerve modulation of HRV during emotional responding in humans.

Semantic hierarchy as a modulator of the concrete-abstract conceptual continuum

Chiara Battaglini, D. Bottari, G. Handjaras, M. Berto, E. Striem-Amit, P. Pietro, A. Lenci, G. Marotta, E. Ricciardi

Abstract

Aim. The aim of this study is to go beyond the traditional differentiation of abstract and concrete concepts on the basis of the level of sensory information needed to process them [1] and assess the importance of the different architecture that is held in mind to represent them [2]. Moreover, we want to understand the neural correlates underpinning the processing of the two classes, by using the N400 wave of the EEG [3]. We hypothesize that abstract and concrete concepts may differ on the level of abstraction needed to process them, with a continuum that characterizes also concrete and superordinate concepts. Our hypothesis is that abstract and superordinate concepts are higher in the abstraction hierarchy, leading to representational structures that are general, flexible and less informative, thus characterized by less predictable contexts. Materials and Methods. To evaluate this hypothesis, we selected 180 stimuli: 60 concrete (CNC), 60 abstract (ABS) and 60 superordinate (SUP) concepts. First, forty-six Italian mother tongue volunteers rated the stimuli with a 5-point-likert-scale according to their concreteness, abstractness and generalizability. Second, ninety-nine additional participants were asked to produce a maximum of ten characteristics to describe the stimuli. These features were then segmented, lemmatized and used to derive mean Relevance and Point Wise Mutual Information for all the three classes of stimuli. Third, a subsample of 51 balanced stimuli were recorded and presented to 20 blindfolded participants who were asked to carefully think about the meaning of the words they heard, while continuous electroencephalogram (EEG) was recorded by 65 electrodes at a sampling rate of 500Hz. Results. From the stimuli norming task, we observed that SUP lie in between CNC and ABS concepts: SUP are more similar to CNC in concreteness and abstractness values while to ABS for generalizability values, being both evaluated as highly generalizable. This was mirrored by the feature production task in which ABS and SUP resulted to be characterized by less informative and less predictable descriptions. This continuum resulted also in the EEG data, with CNC eliciting the largest N400 amplitude, followed by SUP and ABS. Discussion and Conclusion. The results indicate an abstraction continuum: concrete concepts lie at the lower side, maintaining a semantic representation which is more detailed and specific to the element it refers to and more grounded to sensory information, abstract concepts are at the highest side, characterized by a general, less detailed and more abstracted semantic structure, and superordinate concepts lie in between.
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Effector-selective modulation of the effective connectivity within frontoparietal circuits during visuomotor tasks

Federica Bencivenga, M. Tullo, T. Maltempo, A. Von Gal, C. Serra, P. Sabrina, G. Gaspare

Abstract

The collection of research on the human homologues of macaque parietal areas involved in finalized movements led to a lack of consensus on the topic, mainly due to issues in the activation studies performed with functional magnetic resonance imaging (fMRI). Indeed, a wide set of studies using fMRI detected overlapping activations in the parietal cortex during both saccades and reaching or pointing movements (for a review, see Vesia and Crawford, 2012). Here, we attempted to shed more light on this topic by applying a combined approach of individual surface-based and connectivity analyses. We reanalyzed previously collected BOLD data in our laboratory on pointing movements executed with either hand, foot or saccades (Pitzalis et al., 2019) with a threefold aim: a) segregating regions in the parietal cortex that underlie different visuomotor tasks through an individual surface-based analysis (SBA); b) exploring the parieto-frontal functional connectivity during resting state; c) employing an effective connectivity analysis (Dynamic Causal Modelling; DCM) to assess the dynamic fronto-parietal interactions that subserve the execution of visuomotor tasks. First, we found evidence of segregated areas in the posterior intraparietal sulcus, namely a medial (mpIPS) and a lateral (lpIPS) region. These areas were differently engaged during both pointing movements (regardless of the effector) and saccades. Beyond that, from a connectivity perspective we found evidence of preferred signal routes linking parietal and frontal areas at rest. Similarly, the DCM analysis revealed feedforward-feedback loops linking lpIPS and the frontal eye fields (FEF) during saccades and mpIPS and the premotor cortex (PMd) during pointing in an effector-specific fashion. As a matter of fact, in the present study the activation analysis depicted only a partial view of the subtle functional differences occurring between adjacent but distinct subregions. For instance, mpIPS and the human PEc (hPEc) appeared to be recruited to the same extent during hand and foot pointing, but when looking at effector-specific connectivity profiles crucial differences emerged. This finding does not point toward an incongruence between the two types of analyses, but rather emphasizes their different ability in unveiling on the one hand, if some areas are recruited across conditions, on the other hand, how they are recruited across conditions. Overall, our study suggests the existence of a variety of fronto-parietal networks that dynamically recruit common areas depending on the contextual requirements. References: Pitzalis, S., Serra, C., Sulpizio, V., Di Marco, S., Fattori, P., Galati, G., Galletti, C., 2019. A putative human homologue of the macaque area PEc. NeuroImage 202, 116092. Vesia, M., Crawford, J.D., 2012. Specialization of reach function in human posterior parietal cortex. Exp Brain Res 221, 1â€“18.

The role of readiness potential in motor-induced visual suppression

Alessandro Benedetto, H. T. Ho, M. C. Morrone

Abstract

Visual suppression of sensitivity often occurs at the time of a voluntary action, such as saccadic eye-movements, hand-movements, speech, etc. It has been suggested that the suppression results from a corollary discharge signal from the pre-motor cortex, which informs sensory processing of the upcoming movement. Here, we investigate whether motor-induced suppression of visual processing involves predictively the pre-motor activity of the readiness potential. We recorded EEG activity from 18 human volunteers and estimated motor-induced visual suppression in a spatial-frequency discrimination task (visuomotor task). Participants made a voluntary button press, following which two brief gratings with slightly different spatial frequencies were presented, after a delay chosen randomly from 18 possible

stimulus onset asynchronies (SOAs) ranging from 16 to 800 ms. Participants had to locate the grating with the higher spatial frequency by verbally responding 'up' or 'down'. In a separate block, they were simply asked to press a button at their own pace, without any visual stimulation (motor-only task). Results show that (i) discrimination of stimuli presented close to the button press (visuomotor delay < 150 ms) was less accurate than those presented long after action-onset (visuomotor delay > 600 ms), suggesting visual processing was suppressed by motor-related mechanisms. (ii) The magnitude of the motor-induced suppression correlated across subjects with the magnitude of the EEG readiness potential. (iii) A similar correlation was observed between the same behavioural effects in the visuomotor task, and the amplitude of the readiness potential estimated in the motor-only task without visual stimulation. Taken together, our results point to an automatic and predictive link between the readiness potential and visual processing and suggests that the signal from the (pre-)motor to the sensory brain areas is mediated by the readiness potential.

A diagnostic approach in consciousness disorders assessment

Lilla Bonanno, V. Lo Re, S. Marino, S. Casarotto, S. De Salvo, F. Avorio, G. Panarello, D. Palma, N. Muscarà, F. Corallo, G. Hassan, E. Varoli, A. Quartarone, L. Romero-Lauro

Abstract

The present work showed preliminary data a project which assess a multimodal approach that integrates standard clinical observations with brain activity assessed by Structural and Functional Magnetic Resonance Imaging (sMRI and fMRI) and neurostimulation data from TMS-EEG. We reported also the neuroimaging data. We assess to improve the differential diagnosis between minimally conscious patients (MCS) and patients with non-responsive wakefulness syndrome (UWS). Six DoC (5 UWS; 1 MCS) diagnosed according to the standard clinical approach (CRS-R [1]) meanly aged 62.0Â±18.3 years were found eligible for this study according to the inclusion/exclusion criteria. All patients underwent a MRI examination with a scanner operating at 3.0 T (Achieva, Philips Healthcare, Best, The Netherlands), by using a 32-channel SENSE head coil. For each subject, T1-weighted sequence and resting-state functional magnetic resonance imaging (fMRI) scan were acquired. T1-weighted structural MRI images were analyzed by using the Voxel-Based Morphometry (VBM) approach, while, analysis of resting-state fMRI data was performed by using FSL software (FMRIB's Software Library). For this analysis we considered the Default Mode Network (DMN). Patients were experimentally studied in an early phase after the neurological event (4.0Â±2.0 months after the injury). VBM analysis did not highlight anatomical differences between patients, while, fMRI data showed differences in activation. In particular, the MCS patient showed activation in medial and superior frontal gyrus, posterior precuneus, bilateral middle temporal gyri extending into inferior parietal lobule and caudate. Activations in anterior superior frontal gyrus, bilateral temporal gyri were found in four UWS patients and one patient also showed activation of posterior precuneus. Only one patient showed reduced DMN activation limited to the right prefrontal area and no significant activation in the posterior regions. To date, it has been demonstrated a correlation between residual DMN connectivity and level of consciousness in brain-injured patients, in order to perform a difference between MCS and UWS [2,3]. In particular, the presence of significant connectivity in both frontal and posterior regions, with a crucial role of the precuneus, seems to play a key role to differentiate MCS from UWS because the precuneus is involved in visuo-spatial imagery, episodic memory retrieval, self-processing and consciousness. In fact the UWS patient with precuneus activation seems to convert to MCS. Our findings could help the clinicians: a) to perform a correct diagnosis in DOC patients; b) to establish a therapeutic and rehabilitative program; c) to obtain prognostic markers.

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Combined effects on motor cortical excitability of prismatic adaptation and cerebellar tDCS

Rosario Emanuele Bonaventura, A. Giustiniani, M. Oliveri

Abstract

Prismatic adaptation (PA) is a visuomotor procedure that uses prismatic lenses to shift the visual field of the subject. Recent studies have shown an increase of motor cortical activity ipsilateral to the deviation side induced by the lenses (Bracco et al., 2018; Magnani et al., 2014). PA is strictly related to the activation of the cerebellum. Here, we investigated any modifications of the excitability of the motor cortex following the combination of PA with cerebellar neuromodulation via cathodal tDCS. A sample of 6 subjects (mean age= 25.5, SD= 0.9 years) was recruited. Each subject participated in 2 experimental sessions: rightward PA + left cerebellar cathodal tDCS; rightward PA + sham left cerebellar tDCS. Each session was preceded and followed by assessment of the right primary motor cortex excitability using single-pulse transcranial magnetic stimulation (TMS). 2 mA current was delivered through a tDCS stimulator for 15 min during the PA protocol. The cathodal electrode was placed over the left cerebellum. The anodal (reference) electrode was placed on the right cheek. Sham stimulation was performed in the same way as active stimulation but the stimulator was turned off after 1 min. Single-pulse TMS was applied on the right M1, recording MEPs from the left first dorsal interosseous muscle at 4 different intensities (100%;110%;120%;130% of the motor threshold) to perform an input output curve measure. In the absence of PA, left cerebellar cathodal tDCS increased the slope of the TMS input-output curve as compared with baseline ($p < 0.05$). An increase in the slope of the TMS input-output curve was also observed following PA + sham left cerebellar tDCS vs. baseline ($p < 0.05$). When PA was combined to real cerebellar tDCS, there was a reduction of the slope of the TMS-input output curve ($p < 0.05$). PA increases motor cortical excitability of the hemisphere ipsilateral to visual field deviation. Reduction of motor cortical excitability when PA is combined with cathodal cerebellar tDCS can be related to the direct involvement of the cerebellum in the PA as well as to homeostatic plasticity, since both rightward PA and left cathodal cerebellar tDCS increase right motor cortical excitability. References: Bracco, M., Veniero, D., Oliveri, M., & Thut, G. (2018). Prismatic Adaptation Modulates Oscillatory EEG Correlates of Motor Preparation but Not Visual Attention in Healthy Participants. The Journal of Neuroscience, 38(5), 1189â€“1201. https://doi.org/10.1523/jneurosci.1422-17.2017 Magnani, B., Caltagirone, C., & Oliveri, M. (2014). Prismatic adaptation as a novel tool to directionally modulate motor cortex excitability: Evidence from paired-pulse TMS. Brain Stimulation, 7(4), 573â€“579. https://doi.org/10.1016/j.brs.2014.03.005

On the road of memory: investigating the relationship between memory, spatial navigation, and Deja-vu

Alessia Bonavita, A. Teghil, C. Guariglia, M. Boccia

Abstract

Objectives: This work has dual objectives, namely investigating the relation between memory and spatial navigation and that between memory and Deja-vu. Materials: The experimental protocol included: spatial navigation tasks assessing route (RK), landmark (LK), survey (SK) knowledge and landmark ordering (LO), Survey of Autobiographical Memory (SAM), Prospective and Retrospective Memory Questionnaire (PMRQ), I-DEA questionnaire for assessing Deja-vu. Participants and methods: 44 healthy participants took part in this study. Accuracy and a response time index were computed for each spatial navigation task. Four memory dimensions were extracted from SAM: episodic (SAM-E), semantic (SAM-SE), spatial (SAM-SP), and

future (SAM-F). Eight factors were extracted from PMRQ, namely Prospective short-term self-cued (PSTSC), Prospective short-term environmentally-cued (PSTEC), Prospective long-term self-cued (PLTSC), Prospective long-term environmentally-cued (PLTEC), Retrospective short-term self-cued (RSTSC), Retrospective short-term environmentally-cued (RSTEC), Retrospective long-term self-cued (RLTSC), Retrospective long-term environmentally-cued (RLTEC). Results: Two-tail Spearman correlations were performed between the abovementioned variables. Results showed a negative correlation between RL and RSTSC; a positive correlation between the response times of RL and SAM-F; a negative correlation between response times on LK and PLTEC; a negative correlation between accuracy on SK and RSTEC and a positive correlation between accuracy on SK and SAM-SP; a negative correlation between accuracy on LO and RSTEC and a positive correlation between response times on LO and SAM-F. Also, results show a positive correlation between I-DEA and SAM-E as well as SAM-F. Discussion: Memory and planning processes have been hypothesized to have evolved from mechanisms developed to support spatial navigation[1]. Our results show that environmental cues, that elicit retrospective short-term memory, can serve as environmental beacons; instead, self-cued retrospective short-memory can play a role when we have to constantly update our location. Both these mechanisms can support path integration and spatial update processes[2]. Deja-vu may be associated with different neural responses in several brain regions involved in memory and emotional processes, including the hippocampus[3]. Conclusions: Our results show a connection between Deja-vu and the self-perceived abilities to relive past events or imagine future ones. This is consistent with the role of the hippocampus in facilitating the construction of timeless scenes that allow recovering details linked to episodic memories and to imagine future scenes. However, our study is exploratory and further investigations are needed. References: 1. BuzsÃ¡ki, G., & Moser, E. I. (2013). Memory, navigation and theta rhythm in the hippocampal-entorhinal system. In Nature Neuroscience (Vol. 16, Issue 2, pp. 130â€“138) He, Q., & McNamara, T. P. (2018). Spatial Updating Strategy Affects theReference Frame in Path Integration. Psychonomic Bulletin and Review, 25(3), 1073â€“1079. Nigro, S., Cavalli, S. M., Cerasa, A., Riccelli, R., Fortunato, F., Bianco, M. G., Martino, I., Chiriaco, C., Vaccaro, M. G., Quattrone, A., Gambardella, A., & Labate, A. (2019). Functional activity changes in memory and emotional systems of healthy subjects with dÃ©jÃ vu. Epilepsy and Behavior, 97, 8â€“14.

Asymmetric spatiotemporal dynamics of phosphene perception after lateralized occipital cortex stimulation

Davide Bonfanti, C. Mazzi, A. Tafuro, S. Savazzi

Abstract

Background and aim: The purpose of this study is to shed light on the spatiotemporal neural dynamics necessary for visual perception to emerge, and specifically to check for possible differences between the two hemispheres in this process. To do so, we used transcranial magnetic stimulation (TMS) over left and right visual cortex to trigger phosphenes (i.e. the conscious experience of light without light entering the eyes), while recording the elicited activity through EEG in order to detect when conscious and unconscious processing start to diverge. Materials and methods: 18 participants were tested in the experiment. Firstly, we determined an individual phosphene threshold (i.e. the stimulation intensity at which participants could perceive a phosphene on 50% of trials) per each stimulation site (i.e. the occipital electrodes O1 and O2, respectively for the left and right hemisphere), which was employed thereafter as stimulation intensity. During the experimental sessions, single-pulse TMS was administered at threshold intensity and participants reported the presence or absence of a phosphene by pressing respectively two keyboard keys. Each experimental session comprised 360 TMS pulses and the order of stimulation sites was counterbalanced across participants. Results: We did not find any effect of the stimulation site on the recorded TMS-evoked potentials (TEPs). However, the main effect of phosphene perception was significant: we found a bilateral occipito-parietal cluster between 60 and 80 ms, followed by a right temporal cluster starting at 150 and ending at 250 ms; finally, the last cluster starts at 300 ms up until the end of the epoch and develops over centro-parietal electrodes. Given the significant interaction between site and awareness,

we also contrasted trials where the phosphene was present with those without any perception, separately for the two sites. Phosphene perception following left stimulation elicited parieto-occipital activity at around 80 ms and between 150 and 200 ms; in contrast, activity after O2 stimulation was mainly located over centro-parietal electrodes at later latencies, from 300 ms onwards. Discussion and conclusion: The above results support the hypothesis that the two hemispheres are not equivalent at a perceptual level: the perception of a phosphene highlighted a hemisphere-specific pattern of activity, with early occipital activations when stimulating the left occipital cortex and late centro-parietal activity after targeting the right occipital cortex. This may constitute further evidence for the hemispheric specialization hypothesis, showing that such differences are not limited at higher cognitive functions, but concern also lower perceptual mechanisms.

Effects of Transcranial Direct Current Stimulation on the neural substrates of conceptual representations

Ilaria Borghi, S. Bonnì, M. Maiella, E. Casula, C. Caltagirone, G. Koch, G. Gainotti

Abstract

The aim of this study was to shed light on the neural substrate of conceptual representations. Specifically, we investigated the conceptual representation substrate of (a) stimuli belonging to biological and artifact categories; (b) format of stimuli presentation, i.e., verbal or pictorial, and (c) the relation between stimuli i.e., categorial or contextual. To do so, we administered anodal Transcranial Direct Current Stimulation (tDCS) during the execution of a semantic task (â€˜Thematic and Taxonomic Semantic (TTS) taskâ€™, Gainotti et al., 2020). Twenty healthy participants were enrolled and divided into two groups, one investigating the role of the anterior temporal lobes (ATL), the other the temporo-parietal junctions (TPJ). Each participant underwent three sessions of stimulation in order to have a control condition and to investigate the role of both hemispheres. TTS task accuracy and reaction times were analyzed. We observed (1) a worsening in accuracy during left ATL stimulation in the verbal presentation of living categories and an RT slowdown during right ATL stimulation in the pictorial presentation of the same categories. Furthermore, we observed (2) an RT worsening in the pictorial presentation of taxonomic relations when stimulating right ATL. (3) No evidence was found of TPJ implication in conceptual representation, a marginal influence of TPJ stimulation was only suggested by the reduction of accuracy during right TPJ stimulation found in the verbal presentation of the non-living categories. Our first result is consistent with models assuming that the ATLs play a critical role in the representation of biological entities, mainly â€˜storedâ€™ in a verbal format in the left ATL and in a pictorial format in the right ATL. The second result is in line with models assuming that pictorial representations may be subsumed by the right ATL and that taxonomic relations, being mainly based upon a convergence of perceptual features, may be preferentially subsumed by the ATLs, where these features converge. Finally, regarding the third result, several authors suggested that the parietal areas may play an important role in the representation of tools. However, according to these models, a critical role in this function should be played by the left fronto-parietal cortices rather than by the right TPJ cortices. In conclusion, our results are consistent with models assuming that different â€˜higher-order convergence zonesâ€™ may subsume distinct conceptual categories and their verbal or non-verbal representations, whereas they do not support models surmising that distinct semantic relations relay of different neural substrates. References: Gainotti, G., BonnÃ¬, S., Maiella, M., Carretta, J., Zigiotto, L., Sarubbo, S., & Papagno, C., A Case of Right Temporal Lobectomy for Brain Tumor With Selective Semantic Pictorial Disorder, Cognitive and Behavioral Neurology, 2020, 33(1), 52â€“62.

Ageusia and Anosmia in COVID-19 patients: how the olfactory and gustatory perceptions can be connected to stress, somatization, the levels of familiarity, and emotionality of the olfactory/gustatory stimulus

Ilaria Bruno, R. Moretti, M. Settimo, S. Invitto

Abstract

The related COVID-19 symptomatology involves, in addition to the respiratory aspects, also sensory and psychophysiological aspects. Symptoms related to anosmia and ageusia are known, which can persist in the medium and long term. This study investigated phenomena related to anxiety and stress, cognitive self-assessment, olfactory perception, and gustatory perception. These two senses are connected as most of the flavors we perceive are perceived through the nose rather than through the tongue, the flavors spread in the oral cavity and produce a mixed sensation of gustatory and olfactory perception, and therefore the loss of taste is often a natural consequence of the loss of smell. The present work evaluated, through a self-evaluation modification of the Sniffing Test (taking into consideration both the general perception aspect of the odorous stimulus and the perception of the intensity of the same), the test on somatization, the test on perceived stress, and a variation Sniffing for comparative gustatory self-assessment (perception of taste and perceived intensity of flavors). 205 patients with previous COVID_19 infection (165 women) from different Italian regions (mean age 40 years), evaluating all the above aspects. ANOVAs Repeated Measurements were carried out for the olfactory perception, considering as the Between level the degree of Anosmia and the Within factor the Odor (12 levels) and the Time (2 Levels: Pre and Post-infection with COVID-19), the level of familiarity and the level of emotionality of the smell presented were considered as covariates. The gustatory perception we considered as between factor the degree of Ageusia and as between factor the Taste (10 Levels) and the Time (2 Levels: Pre and Post COVID-19). Repeated measures ANOVAs were also carried out for the smell considering the perceptual factor (2 levels: general perception of the odor; the intensity of perception of the odor), the time factor (2 Levels; pre and post COVID-19). The analyzes revealed significant differences in odor perception, intensity, the familiarity with the odor, and levels of anosmia and ageusia. The stress factor also affects the intensity of the symptoms, unlike the level of somatization, which seems to have no impact. The analysis also highlighted gender differences in the direction of greater anosmia / ageusic symptoms in women. The limitations of this study are the strong imbalance of the sample towards greater representativeness of the female gender compared to the male one.

Using Virtual Reality and Embodiment illusion to alter Body Image Distortion in Anorexia Nervosa

Ilaria Bufalari, I. Provenzano, S. Ciccarone, G. Porciello, M. Petrucci, B. Cozzani, A. Cotugno

Abstract

Body Image Distortion (BID) is a core symptom of Anorexia Nervosa (AN). Despite being underweight, anorexic patients report an overestimation of their body size and a high level of dissatisfaction toward their appearance. Recent experimental evidence suggests that Immersive Virtual reality (IVR) and Full Body Illusion (FBI) can be used to alter the BID found in anorexic patients. In the current study we investigated whether the embodiment of differently sized virtual bodies could reduce BID in AN, as indexed by body perception (BP) and body schema (BS) measures. Embodiment was induced through synchronous IMS over an underweight avatar (BMI = 15) and a normal weight avatar (BMI = 19). BID was measured by asking our participants (19 anorexics, 24 healthy controls) to estimate: 1) their hips width with a ruler while their vision was occluded (BP); 2) the minimum apertureâ€™s width required to walk through a virtual door aperture without twisting their body (BS). Results show that synchronous IMS was successful in inducing an embodiment illusion. Interestingly, being exposed to the normal (vs. under-) weight avatar induced the sensation of being fatter than usual in AN patients, but not in controls. Also, all participants reported to feel thinner than usual after the synchronous IMS with the underweight BMI avatar compared to all the other conditions. Normal weight avatar was considered by all participants as the most similar to their actual body, and AN patients rated it as the least attractive and the most disgusting, thus confirming the body dissatisfaction component of body image disturbance in AN. Remarkably, being exposed to underweight (compared to the normal weight) BMI avatar resulted in lower hips and door aperture width estimations in

all participants. Importantly, the difference in door aperture width estimation was specific for the synchronous IMS condition and occurred only in AN patients: AN participants reported larger door aperture widths after the embodying the normal weight avatar with respect to the underweight avatar. To our knowledge, this is the first study to report a distinct effect of a synchronous full body illusion on anorectic patientsâ€™ body image and results support the idea of an increased bodily self-plasticity in people with eating disorders compared to neurotypical individuals. Future researches are needed to establish protocols that could take advantage of IVR and IMS to reduced both body dissatisfaction and overestimation in AN.

Mine or Yours? Frequency tagging reveals an implicit neural index of hand identity recognition in the human brain

Nicolò Castellani, M. Galigani, M. Mancano, E. Pizzolla, M. Podestà, D. Bottari, F. Garbarini

Abstract

As suggested by neuroimaging evidence [1], the visual processing of the own and someone else's body recruits different neural mechanisms and circuits. Critically, self-recognition has been studied mainly within the face processing system and electrophysiological signatures of self-face recognition have been identified. However, while human beings never have a direct vision of their face, we have a direct view of our and otherâ€™s hands while interacting with the environment. Nevertheless, the discrimination between the own and other's hand is still poorly explored. In the present study, we aim at identifying an objective marker of hand identity recognition, taking advantage of a fast periodic visual stimulation (FPVS) approach. Sixteen healthy right-handed subjects (9 women) aged 19-29 years (meanÂ±SD: 24 Â±2.16; years of education: 17.44 Â±1.36) were presented with visual stimuli consisted of grey-scale pictures (10x15 cm) of the dorsum of open right hands belonging either to the participants or to other people. FPVS [2] was applied, with a squared on-off presentation (duration of stimulus: 80 ms; interstimulus interval: 170 ms) at the base frequency of 4 Hz. Images of hand depicting the subjects' hand (Self hand) and another person's hand (Other hand) were presented in an egocentric perspective (Upright) or an allocentric perspective (Inverted), thus yielding four different conditions (Self Upright, Self Inverted, Other Upright, and Other Inverted). To investigate amplitudes of frequency tagging responses elicited by visual stimuli, the sum of baseline subtracted amplitudes in each condition was entered in a 2*2 repeated measures ANOVA with Identity (Self and Other) and Orientation (Upright and Inverted) as within-subject factors. Crucially, we chose a region of interest identified as the electrodes with the greatest amplitudes (O1, Oz, O2). Crucially, the analysis revealed a significant Identity*Orientation interaction (F1,15=4.69; p=0.04; Î·2p=0.24), showing significantly greater responses in Other Inverted as compared to all the other conditions (p always < 0.02, at Fisherâ€™s LSD post hoc comparisons). Taken together, our findings show a preference for the otherâ€™s hand in an allocentric view (i.e., Inverted), suggesting that the enhanced neural activity for body stimuli presented in allocentric perspective, previously highlighted by neuroimaging studies [3], seems to be specific for the other body that, in our everyday life, is usually perceived in an allocentric perspective. References: Hodzic A, Muckli L, Singer W, Stirn A. Cortical responses to self and others. Hum Brain Mapp. 2009;30(3):951-962. doi:10.1002/hbm.20558 Norcia AM, Appelbaum LG, Ales JM, Cottereau BR, Rossion B. The steady-state visual evoked potential in vision research: A review. J Vis. 2015;15(6):4. doi:10.1167/15.6.4 Saxe R, Jamal N, Powell L. My body or yours? The effect of visual perspective on cortical body representations. Cerebral Cortex. 2006;16: 178â€“182. doi:10.1093/cercor/bhi095.

Improvement of cognitive symptoms in SARS-COV2 related encephalitis following prefrontal rTMS

Angela Catania, P. Turriziani, M. Oliveri

Abstract

AIMS: According to the HERA model, left and right prefrontal cortices are respectively involved in retrieval and encoding of memory traces. Previous studies showed that inhibitory repetitive transcranial magnetic stimulation (rTMS) of the right DLPFC enhanced recognition memory in healthy subjects as well as in

patients with amnestic Mild Cognitive Impairment and Alzheimerâ€™s disease. The aim of the present study was to investigate the efficacy of this low frequency rTMS protocol in a patient with limbic encephalitis associated to SARS-COV2 infection. MATERIALS: Neuropsychological examination evaluated global cognitive functioning (Mini Mental State Examination, Colored Progressive Matrices), verbal (Digit span test forward) and visuospatial (Corsi block-tapping test forward) short-term memory, verbal (Digit span test backward) and visuospatial (Corsi block-tapping test backward) working memory, verbal (15 Reyâ€™s word list immediate and delayed recall and recognition) and visuospatial (Reyâ€™s Figure delayed recall) episodic memory, semantic memory (Sartoriâ€™s semantic batter) attention (Attentional matrices, Short Stroop Test), executive functions (Modified Wisconsin Card Sorting Test, Simplified Tower of London Test, Modified Five Point Test), constructive praxis (Copy of Reyâ€™s figure, Copy of drawings), verbal and semantic fluency. TMS was delivered using a MagStim Super Rapid 2 biphasic magnetic stimulator through a 70 mm figure-eight coil.
METHOD: After the baseline examination the patient was submitted to 10 rTMS sessions. Stimulation intensity was at 90% of motor threshold of the right hemisphere. The coil was placed on the right DLPFC, on a site corresponding to BA 46/9. In each session, the patient received 600 stimuli at a frequency of 1 Hz. RESULTS: After the 10 rTMS sessions there was a significant improvement on global cognitive functioning, verbal and visuospatial working memory, verbal and visuospatial episodic memory, semantic memory, attention, executive functions, constructive praxis, verbal and semantic fluency. DISCUSSION: The patient is a 44 years old male that in October 2020 was hospitalized for high fever and mental confusion. Molecular nasofaringeal swab revealed positivity for SARS-COV2. Cerebral Magnetic Resonance Imaging showed bilateral hippocampal hyperintensity. Brain Positron Emission Tomography scan revealed glucidic hypometabolism of bilateral mesial temporal lobes including hippocampi. Cerebrospinal fluid analysis didnâ€™t find anomalies. Baseline neuropsychological evaluation showed scores below the mean for age and education on visuospatial working memory, verbal and visuospatial episodic memory, semantic memory, attention and executive functions. CONCLUSIONS: Inhibitory rTMS on the right DLPFC can be successful tool to improve cognition not only in neurodegenerative disorders but also in acquired brain damage as encephalitis. References: Endel Tulving, Shitij Kapur, Fergus Craik, Morris Moscovitch, Sylvain Houle. Hemispheric encoding/retrieval asymmetry in episodic memory: positron emission tomography findings. Proc Natl Acad Sci U S A. 1994 Mar 15;91(6):2016-2020. Patrizia Turriziani, Daniela Smirni, Giuseppe ZappalÃ, Giuseppa Renata Mangano, Massimiliano Oliveri, Lisa Cipolotti. Enhancing memory performance with rTMS in healthy subjects and individuals with Mild Cognitive Impairment: the role of the right dorsolateral prefrontal cortex. Front Hum Neurosci. 2012; 6: 62. Patrizia Turriziani, Daniela Smirni, Giuseppa Renata Mangano, Giuseppe ZappalÃ, Andreina Giustiniani, Lisa Cipolotti, Massimiliano Oliveri. Low-Frequency Repetitive Transcranial Magnetic Stimulation of the Right Dorsolateral Prefrontal Cortex Enhances Recognition Memory in Alzheimer's Disease. J Alzheimers Dis. 2019;72(2):613-622.

How you see you remember: viewing strategy more than fixation topography shapes scenes recollection

Miriam Celli, M. Celli, A. Zangrossi, G. Cona, M. Corbetta

Abstract

The interdependence between eye movements during exploration of a visual scene and its recollection has been noted in the past, but it has never been examined quantitatively. Here we examine two questions. First, is there a significant relationship between maps of eye movement fixation and maps of object memory recall? Second, do eye movement fixation maps depend on the complexity of the visual image or individual dynamic features? 120 healthy participants were instructed to look at 185 pictures while their gaze was recorded with a Tobi T120 eye-tracker. Five of the pictures were repeated five times to promote incidental memorization. Participants were asked to verbally recall these pictures in a element-by-element manner while their voice was recorded. Fixation density maps (FDMs) were created by extracting fixations during free-viewing of scenes. Memory maps were created by selecting regions of interest in

correspondence of the visual objects serially recalled. The memory maps were created based on the audiotape recorded during recall by three independent reviewers who noted objectâ€™s name, order, and time of recall. A 2Â° FWHM blur was then applied to all maps. Memory heatmaps were compared to FDM by means of the FROA approach (Johnston and Leek, 2007) that computes the degree of overlap between maps (actual overlap percentage, AOP). The individual significance of AOP values was determined based on a null distribution of random overlaps. Subsequently, we built a set of regression mixed-effects models to predict AOP with subjects and image category as random effects and image-specific (i.e., visual complexity) and subject-specific factors (i.e., visual exploration strategy, mean saliency and semantic information in fixations) as fixed effects. The overlay between FDMs and memory maps was significantly predicted by visual complexity and visual exploration strategy. The AOP between FDMs and memory maps was lower for more complex images and for visual exploration strategies characterized by longer and fewer fixations. Growing evidence suggests that overt attention (as indexed by FDM) strongly shapes memory (e.g., Damiano and Walther, 2019). We find that the extent to which FDMs are overlayed to memory maps is strongly affected by individual differences and modulated by individual and image specific features. In the present we evaluate the interplay between eye movements (i.e., FDM) and visual memory topography. Our results suggest that the degree to which visual exploration of scenes predict the subsequently recalled details was significantly modulated both by image-specific features and individual viewing strategy. References: Johnston, S., & Leek, C. (2007). Fixation region overlap: A quantitative method for the analysis of fixational eye movement patterns. Journal of Eye Movement Research, 1(3). Damiano, C., & Walther, D. B. (2019). Distinct roles of eye movements during memory encoding and retrieval. Cognition, 184, 119-129.

Emerging of new bioartificial corticospinal motor synergies using a robotic additional thumb

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Abstract

Aim of the study: It is still unknown whether humans using an augmented six-fingered hand (the natural five plus a robotic one) modify corticospinal motor synergies controlling hand actions. Materials and methods: As imagined and executed movements share common neural acitivities, we measured corticospinal reactivity through muscle responses to transcranial magnetic stimulation of the primary motor cortex during imagery of hand actions performed with or without the Soft Sixth Finger (SSF), a wearable robotic additional thumb patented for helping patients with hand paresis and loss of thumb opposition ability. Results: Healthy humans trained few minutes with the SSFâ€™s use rapidly reshaped their pattern of corticospinal outputs towards extrinsic and intrinsic hand muscles during imagined pinch-grip or grasping-objects actions. Discussion: These neural signatures might explain how the motor system is capable of quickly welcoming emerging bioartificial corticospinal grasping synergies, implying new interactions with objects within the peripersonal space. Findings provide a neurophysiological framework for implementing augmentative robotic tools in humans and for the exploitation of the SSF in conceptually new rehabilitation settings. References: Hussain, I., Spagnoletti, G., Salvietti, G., Prattichizzo, D., 2017b. Toward wearable supernumerary robotic fingers to compensate missing grasping abilities in hemiparetic upper limb. The International Journal of Robotics Research 36, 1414â€“1436. Beckerle, P., Salvietti, G., Unal, R., Prattichizzo, D., Rossi, S., Castellini, C., Hirche, S., Endo, S., Amor, H.B., Ciocarlie, M., Mastrogiovanni, F., Argall, B.D., Bianchi, M., 2017. A Humanâ€“Robot Interaction Perspective on Assistive and Rehabilitation Robotics. Front. Neurorobot. 11. Salvietti, G., Hussain, I., Cioncoloni, D., Taddei, S., Rossi, S., Prattichizzo, D., 2017. Compensating Hand Function in Chronic Stroke Patients Through the Robotic Sixth Finger. IEEE Trans. Neural Syst. Rehabil. Eng. 25, 142â€“150.

Unveiling the neural correlates of visual awareness by means of Fast Optical Imaging and EEG

Elisabetta Colombari, G. Parisi, A. Tafuro, S. Mele, C. Mazzi, S. Savazzi

Abstract

Aim and materials: The aim of the present study is to highlight the neural dynamics involved in perceptual awareness and to disentangle the time course of activation of specific brain regions involved in this cognitive process. This was made possible by the use of two different but complementary techniques: a) Event-Related Optical Signal (EROS), that is an optical imaging technique which allows recording the fast optical signal related to the neuronal activity and b) Electroencephalography (EEG), which allows recording the brain electrical activity elicited by a specific event with high temporal resolution. Methods: The study was composed of two experiments: first participants underwent EROS recording (Experiment 1), and then EEG recording (Experiment 2). The experimental paradigm was the same and it consisted in carrying out a behavioral task while brain activity was recorded. Participants were asked to discriminate the orientation of a stimulus and then to report whether they had seen or not its orientation. In this way, it was possible to sort trials according to conscious or unconscious experience of the observer. Before the experimental session, the stimulus to be used was determined for each participant by means of a threshold assessment.Results: Accuracy was significantly higher for aware trials in both the experiments, suggesting that in the Aware condition participants could properly discriminate the orientation of the stimulus. EROS results (Aware vs Unaware contrast) showed a sustained increase of activation in the Lateral Occipital Complex (LOC) from 179 ms to 307 ms after the presentation of the stimulus. ERP results suggested that aware trials elicited a significant posterior negativity (i.e. Visual Awareness Negativity, VAN) in the 160-424 ms time window, followed by an enhanced positivity (i.e. Late Positivity) peaking at parietal electrodes in the 432-732 ms time window. Discussion and conclusions: EROS results suggested that aware trials elicited an increased activity of the LOC, a cortical area involved in object recognition, probably reflecting the effective recognition of the stimulus. This sustained activation of the LOC occurred at a time window corresponding to the VAN, suggesting that this area could effectively serve as a correlate of visual awareness, since it is widely accepted that the VAN consistently correlates with visual awareness. In conclusion, what these results suggest is that visual awareness seems not to reside in the neural coding within the primary visual cortex, but it arises in later stages of the visual processing, more specifically in LOC.

Mapping of Space, Time and Numbers in the brain: From ATOM to GradiATOM

Giorgia Cona, M. Wiener, C. Scarpazza

Abstract

Aims. A prominent theory - â€œA Theory of Magnitudeâ€• (ATOM) by Walsh (2003) - posited that time, space, and numbers are coded by a common magnitude system in the brain. No study, however, has clearly identified such â€˜core network of magnitudeâ€™ so far. The first aim of the present study was to carry out a meta-analysis of neuroimaging studies in order to pinpoint the regions that are commonly and consistently activated across the three magnitudes, regardless of the specific task or stimuli used. The second aim was to delineate not only where the magnitudes overlap in the brain, but also the extent of such overlap. The third aim was to explore spatial organization among the magnitudes, focusing on testing the existence of a gradient transition among time, space and number representations in the brain. Materials. Following PRISMA guidelines, we included in the analysis a total of 112 experiments (for space domain), 114 experiments (time domain) and 115 experiments (numerosity domain). Methods. We performed a meta-analysis of neuroimaging studies using the Activation Likelihood Estimation method in order to determine the set of regions commonly activated in space, time and numerosity and to establish the neural activations specific to each magnitude. Results. We found a system of brain regions that was

commonly recruited in all the three magnitudes, which included: bilateral insula, the supplementary motor area (SMA), the right inferior frontal gyrus and bilateral intraparietal sulci. Overall, numbers/time showed less activation overlap (13%) than numbers/space (36%). This pattern existed across the three regions of interest. Very well-defined number-time gradients and space-time gradients were found, while the number-space gradients were less clear, corroborating the idea of higher spatial overlap between the two domains. Discussion. Our study identified the â€˜core network of magnitudeâ€™, wherein a common set of regions is shared by space, time and numbers. Also, while space/numbers share a more overlapping circuitry, time/numbers and time/space occupy gradient-type representations: in the SMA, space and numbers activate more-anterior regions and time activates more-posterior ones; in frontal and parietal regions, space and numbers are mediated by more-dorsal regions, whereas time recruits more-ventral regions. Conclusion. The findings extend the ATOM theory, supporting the â€˜GradiATOMâ€™ theory (Gradient Theory of Magnitude), proposed in our previous study (Cona et al., 2021). According to GradiATOM, gradient organization would enable the interaction of multiple different magnitudes processing to facilitate the integration and/or transformation into a coherent, multi-domain, representation. References: Cona, G., Wiener, M., & Scarpazza, C. (2021). NeuroImage From ATOM to GradiATOMâ€¯: Cortical gradients support time and space processing as revealed by a meta-analysis of neuroimaging studies. NeuroImage, 224, 117407. https://doi.org/10.1016/j.neuroimage.2020.117407 Walsh, V., 2003. A theory of magnitude: common cortical metrics of time, space and quantity. Trends in Cognitive Science, 7 (11), 483â€“488. doi: 10.1016/j.tics.2003.09.002.

Bilateral skin temperature drop and warm sensibility decrease following modulation of body part ownership through mirror-box illusion

Damiano Crivelli, E. Polimeni, D. Crotti, G. Bottini, G. Salvato

Abstract

Aim: Thermoregulation may play a role in maintaining a coherent sense of body ownership. Nevertheless, evidence is conflicting, possibly due to the pitfalls of the experimental paradigms used (e.g., the Rubber Hand Illusion; RHI; 1). In this study, we explored the relationship between body ownership, thermoregulation, and thermal sensitivity through a novel application of the mirror-box illusion (MBI) paradigm (2), with the aim of overcoming some of the limitations of previous studies. Materials & Methods: 36 healthy participants, with their left arm hidden from view, synchronously or asynchronously tapped their left and right index fingers against two parallel mirrors at a constant rhythm while looking at their reflected right hand. At the end of this movement, participants verbally reported the perceived position of their left index finger and the perceived magnitude of the illusion of ownership. Hands skin temperature and thermal sensitivity were measured before and after the tapping. Results: We showed a successful induction of the illusion of ownership for both implicit (proprioceptive drift) and explicit (questionnaire) parameters in synchronous versus asynchronous condition. The illusion was associated with a bilateral cooling of the hands, which correlated with the proprioceptive drift, and reduced thermal sensitivity for warm but not for cold thermal stimuli. Discussion: We interpreted these findings in the framework of the body matrix (3), a dynamic representation of the body through the integration of psychological and physiological parameters, supported by a right-lateralized set of areas. We speculate that the MBI transiently disturbs the neural activity of the network that supports coherent bodily self-awareness, triggering a specific thermoregulatory response. This response would be bilateral considered that these areas support not only the canonical contralateral but also the ipsilateral representation of the body. Concerning the temperature detection task, we speculate that the difference between warm and cold stimuli could be accounted for by the fact that they are transmitted through two different types of afferent fibers. Interestingly, a direct relationship between signals mediated by C-fibers, like warm stimuli, and the sense of body ownership have been reported (e.g. affective touch). Affective touch, which is mediated by the same fibers, enhances body ownership. We hypothesize that this relationship could be bidirectional. Conclusion: Future neuroimaging studies may explore the causal involvement of the body matrixâ€™s

neural areas in top-down thermoregulatory control and thermal sensitivity, and their relationship to the sense of body ownership.References: Botvinick, M., & Cohen, J. (1998). Rubber hands â€˜feelâ€™touch that eyes see. Nature, 391(6669), 756-756. Medina, J., Khurana, P., & Coslett, H. B. (2015). The influence of embodiment on multisensory integration using the mirror box illusion. Consciousness and cognition, 37, 71-82. Moseley, G. L., Gallace, A., & Spence, C. (2012). Bodily illusions in health and disease: physiological and clinical perspectives and the concept of a cortical â€˜body matrixâ€™. Neuroscience & Biobehavioral Reviews, 36(1), 34-46.

Spatial frequency tuning of body gender adaptation

Giulia D'Argenio, A. Finisguerra, C. Urgesi

Abstract

Protracted exposure to distinctively gendered bodies causes strongly biased visual aftereffects in the opposite direction, leading the subsequent categorization of ambiguous bodies toward the opposite sex than that the adapters (e.g., androgynous bodies are perceived as more masculine after adaptation to female bodies). Previous face perception studies have reported that both parvocellular and magnocellular channels are sensitive to face adaptation, but their relative sensitivity to body gender adaptation is yet to be explored. Here, we report a 3-experiment investigation on the parallel, cross-transfer and contingent aftereffects of body gender perception across different band widths of spatial frequencies, namely high- (HSF) and low- (LSF) spatial frequencies, which tap, respectively, on parvo- and magnocellular channels. In Experiment 1, participants were exposed to female or male virtual-human body stimuli, which could be presented non-filtered or containing only HSF or LSF information and were, successively, asked to recognize the gender of a set of non-filtered androgynous models. The results confirmed that, independently from the SF content of the adapting stimuli, prolonged adaptation to a distinctively female or male body made non-filtered androgynous bodies to appear as more masculine or feminine, respectively. This suggests that information from both magnocellular and parvocellular information contained in intact bodies are sensitive to gender body adaptation. In Experiment 2 we tested the transfer of body gender aftereffects across SF by separately using HSF or LSF stimuli in the adapting phase and testing aftereffects on both SF stimuli in the testing phase. Significant aftereffects were obtained for both the adapted and non-adapted SF channels, pointing to cross-channel transfer of body gender aftereffects. In Experiment 3, we tested for contingent aftereffects of LSF and HSF channels by exposing participants, within the same session, to opposite gender-typing features in the two SF channels (i.e., male HSF and female LSF or vice versa), and testing aftereffects on both SF stimuli in the testing phase. The results revealed that, while HSF stimuli were consistently adapted to their SF-tuned gender, no exposure effects were detected for LSF stimuli, suggesting greater HSF-to-LSF cross-transfer of body gender adaptation, which prevented contingent aftereffects of the LSF channel. Taken together, the results suggest that body gender adaptation involves information conveyed by both the parvocellular and magnocellular channels. Furthermore, they suggest that, while gender aftereffects can transfer across SF channels, HSF adaptation may exceed LSF adaptation, pointing to a prominent role of HSF in body gender perception.

Reversed Pseudoneglect in a Virtual Reality Environment

Giuseppe De Lisi, G. Giglia, G. Gambino, N. Ravì, P. Sardo, G. Ferraro, G. Musotto

Abstract

Objectives: the goal of our experiment was to test the differences in visuospatial attention bias in a virtual reality (VR) and augmented reality (AR) context compared to real life and whether VR and AR had an influence on the physiological pseudoneglect in near and far space. Equipment: we used a VRBox with a smartphone inside as a headset and the software Unity3D to generate the VR/AR environments. In VR we also used the Leap Motion as a tracker for handsâ€™ movements in order to give visual feedback of participants movements. In AR condition subjects saw the real world but through device cameras.

Methods: 20 healthy right-handed subjects underwent a line bisection judgement task in four conditions for VR: NEAR (60cm, peripersonal space), FAR (120cm, extrapersonal space), TOOL (120cm with a stick), LONG-ARM (120cm with virtual arms extended up to 120cm). We administered the same task in AR following these three conditions: NEAR, FAR, TOOL. Results: while in AR NEAR, FAR and TOOL conditions results were comparable to those reported in real life, i.e. significant pseudoneglect in the NEAR and TOOL (NEAR vs TOOL n.s) condition that disappears in FAR condition (NEAR vs FAR p=.01, TOOL vs FAR p=.008), in VR in the NEAR, FAR and TOOL conditions showed relative differences comparable to those obtained in literature but the absolute values were inverted (NEAR vs TOOL n.s, NEAR vs FAR p=0.1, TOOL vs FAR p=.01) hence we found an inversion of the physiological pseudoneglect normally observed in real life. Interestingly the LONG-ARM condition showed no significant differences with all other conditions (vs NEAR n.s., vs TOOL n.s., vs FAR n.s.).
Discussion: the inversion of the physiological anisotropy of visual-space attention we observed in VR but not in AR condition seems to suggest a specific effect of Computer Generated Environment since in AR this inversion does not occur, even if the same headset was used. We can hypothesize that the virtual environment is not recognized as analogous to real life by the brain and that this causes a sensory incongruity that is resolved by the brain, according to a Bayesian model, preferring the higher precision stimuli. Conclusions: more research is needed to settle these hypotheses and to verify the potential usefulness of virtual reality in the rehabilitation field for patients suffering from neglect References: Giglia, G., Pia, L., Folegatti, A., Puma, A., Fierro, B., Cosentino, G., et al. (2015). Far space remapping by tool use: A rTMS study over the right posterior parietal cortex. Brain Stimul. 8, 95â€“800.doi:10.1016/j.brs.2015.01.412. Fierro, B., Brighina, F., Giglia, G., Palermo, A., Francolini, M., and Scalia, S. (2006). Paired pulse TMS over the right posterior parietal cortex modulates visuospatial perception. J. Neurol. Sci. 247. doi:10.1016/j.jns.2006.04.006. Ognibene, D., and Giglia, G. (2015). Use of hierarchical Bayesian framework in MTS studies to model different causes and novel possible forms of acquired MTS. Cogn. Neurosci. 6, 144â€“145. doi:10.1080/17588928.2015.1057487.

Vision of haptics tunes the somatosensory threshold

Maria Del Vecchio, D. De Marco, A. Cassisi, P. Avanzini

Abstract

The interplay between visual information and somatosensory perception is largely documented (Lederman and Klatzky, 2004). Nevertheless, which visual features mostly interact with somatosensation (e.g. motion, semantic content) to create a perceptual experience is still an unsettled issue. Previous studies involving single-neuron recordings on macaques (Hihara et al. 2015) and stereo-EEG in drug-resistant epileptic patients (Del Vecchio et al. 2020) underlined that higher-order somatosensensory cortices (i.e., SII) respond during the observation of manipulative actions, suggesting that the presence of a haptic component may represent a key element in the visually-driven modulation of the sensory threshold. In this study, we delivered a tactile stimulation (i.e., median nerve stimulation at the wrist) at the individual sensory threshold to 34 subjects during the observation of videos showing a reach-to-grasp-and-manipulate action. Videos were shown either naturally (V) or in a point-light version tracking only the position of 7 upper-limb markers (PL). The stimulation could occur during the reaching (R) or the manipulation phase (M). Furthermore, we also administered two other control conditions: a static grating (GR) and the same PL video but with the relative position of markers shuffled to prevent the identification of a hand (SH). Conditions were randomly presented and balanced throughout two different experimental blocks. After the end of each stimulus, subjects had to report verbally whether they had felt any stimulation. Statistical analyses included a Repeated Measures ANOVA, with the experimental block (n=2) and condition (n=6; VR, VM, PLR, PLM, GR, PLSH) as factors. Post-hoc analysis has been performed with Newman-Keuls tests. Our results indicate that both the experimental block and condition are significant factors ($p<0.05$); however, no significant interaction was found. Post-hoc analysis indicates that when the stimulation occurs during the manipulation (VM), the percentage of correct detection is significantly higher than all other conditions,

except for PLM. Our data indicate that neither motion nor the observation of a biological effector per se are sufficient to modulate the sensory threshold. Rather, a hand-object interaction must be present in the stimulus - explicitly or implied - to obtain modulation of the sensory threshold. In conclusion, only observing the haptic component of actions may lower the sensory threshold, suggesting new approaches in the treatment of tactile awareness disorders. References: Lederman SJ, Klatzky RL (2004) Multisensory texture perception. In: The handbook of multisensory processes (Calvert G, Spence C, Stein BE, eds), pp 107â€“122. Cambridge, MA: MIT Hihara, Sayaka, et al. "Visual responsiveness of neurons in the secondary somatosensory area and its surrounding parietal operculum regions in awake macaque monkeys." Cerebral Cortex 25.11 (2015): 4535-4550. Del Vecchio, Maria, et al. "Action execution and action observation elicit mirror responses with the same temporal profile in human SII." Communications biology 3.1 (2020): 1-8.

Modulation of cognitive functions using a combination of visuomotor adaptation and digital therapy in Alzheimer's disease

Agnese Di Garbo, F. Calistro, M. Oliveri

Abstract

Objectives. To evaluate the effectiveness of a new medical device, MindLenses, in modulating cognitive functions in mild AD. MindLenses combines digitalized prismatic adaptation (PA) with serious games. Recent neurophysiological research indicates that PA can increase the activation of the hemisphere ipsilateral to prismatic deviation, while inhibiting the activation of the contralateral hemisphere (1). Materials and Method. Ten patients who met the diagnostic criteria for mild AD (5 women, mean age: 73.3, SD: 9.7 years; mean education: 13.22, SD: 6.3 years) underwent a baseline neuropsychological investigation using both mental deterioration battery (MDB) and digital tasks assessing short term verbal and spatial memory, verbal and spatial working memory, verbal and spatial supraspan, verbal and non-verbal recognition memory, phonological and semantic fluency. Patients were then submitted to a two weeks training using MindLenses. In each session, adaptation to leftward PA (20 diopters) was made by recording pointing movements to 90 visual stimuli presented on a tablet. Following PA, patients executed six serious games challenging executive functions, i.e. inhibition, shifting, working memory, decision making, planning. Each session had a mean duration of 30 minutes. After two weeks the patients were evaluated again with neuropsychological tasks.
Results. The training improved phonological fluency ($p = 0.01$) and immediate prose memory ($p = 0.03$) tasks of the MDB. Phonological fluency assessed digitally was also improved ($p = 0.01$). Performance on the other neuropsychological tasks was unchanged. Discussion. Results could reflect a boosting of activation of left frontal and temporal circuits, by analogy with findings suggesting frontal modulation by PA, ipsilateral to the side of prism deviation (1-2). Conclusions. This pilot study suggests a new approach for modulation of executive and memory functions in AD, that hold promise in ease of use and time for producing cognitive effects. Further studies with larger patient samples, control groups and follow up monitoring will be necessary to confirm these findings. References: Gudmundsson L, et al. A brief exposure to rightward prismatic adaptation changes resting-state network characteristics of the ventral attentional system. PLoS One 2020 Jun 25;15(6):e0234382. Bracco M, et al. Prismatic Adaptation Modulates Oscillatory EEG Correlates of Motor Preparation but Not Visual Attention in Healthy Participants. J Neurosci. 2018 Jan 31;38(5):1189-1201.

Modulating spatial orientation by Non-Invasive Brain Stimulation

Marco Di Maira, G. Gambino, P. Sardo, G. Ferrari, F. Brighina, G. Giglia

Abstract

Objectives: Galvanic Vestibular Stimulation is a form of tDCS capable of eliciting a vestibular response through direct nerve stimulation and involvement of posterior labyrinth hairy cells [1] [2]. The main purpose of this preliminary study is to develop an affordable and unexpensive experimental set-up for GVS

modulation protocol that can be used in specialized centers during the flight simulators and spatial illusion simulators, to reduce or better study the Space Disorientation in pilots. Materials: 9 healthy subjects (22-45 years) underwent posturographic study during the GVS, using BrainSTIM(TM) stimulator through a continuous bipolar current of 1mA using 20 cm2 electrodes positioned over the mastoid process with the anode on the left. Wii Balance Board(TM) is able to obtain data on the movements of the COP (Center Of Pressure) [3], deriving it for the X and Y axis from the four force sensors in the platform, and communicate this data to the computer by Bluetooth protocol to BrainBloX software. Method: Subjects were instructed to remain barefoot on the platform, with their eyes closed, the head looking forward, the upper limbs along the body, and the lower limbs spread about 30Â°. 3 tests of 40 seconds each were performed: the first aimed at monitoring the oscillation produced with closed eyes in the absence of stimulation; the last two, on the other hand, are aimed at assessing the inclination produced on the subject because of the GVS. A rest period of approximately 1 minute was provided between the first and second stimuli. Each subject was evaluated for the oscillation along the X axis. A rmANOVA was conducted with the variable COP X as an intrasubject factor and two conditions (pre tDCS vs post tDCS). Results: The analysis of the COP position showed a significant ($p < 0.05$) variation of approximately 0.45 cm (95% CI 0.44-0.46), in line with international studies performed on the healthy population. Discussion/Conclusions: Thanks to the results of this preliminary study it will be possible to apply the discharge protocol developed on aeronautical pilots in order to evaluate the response that the GVS is able to elicit during flight simulation in order to be able to modulate this perception by means of non-invasive brain stimulation. References: Gensberger KD, Kaufmann AK, Dietrich H, Branoner F, Banchi R, Chagnaud BP, Straka H., Galvanic Vestibular Stimulation: Cellular Substrates and Response Patterns of Neurons in the Vestibulo-Ocular Network, Journal of Neuroscience, 2016, 36(35):9097-110 Dlugaiczyk J, Gensberger KD, Straka H., Galvanic vestibular stimulation: from basic concepts to clinical applications, Journal of Neurophysiology, 2019, 121(6):2237-2255. Hubbard B, Pothier D, Hughes C, Rutka J., A portable, low-cost system for posturography: a platform for longitudinal balance telemetry., Journal Otolaryngology Head Neck Surgery, 2012, 41 Suppl 1:S31-5.

Can we modulate visuo-spatial asymmetries during free visual exploration? An HD-tDCS and eye-tracking study

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Abstract

Aims: in the present study, we explore the effects of concentric high definition transcranial direct current stimulation (HD-tDCS) on a behavioral, naturalistic, eye tracking-based task: the free visual exploration task. This task has been used on both healthy participants and brain-lesioned patients with hemispatial neglect and proved promising to measure visuo-spatial attention. Specifically, we wanted to test in healthy participants whether a single session of right-hemispheric, anodal HD-tDCS could modulate visuo-spatial asymmetries and exploration patterns, also taking into accounts inter-individual variability. Materials: 22 healthy participants took part in the experiment. The task consisted in the free exploration of sets of 25 naturalistic pictures balanced for left-right saliency (7s of exploration for each picture) while their gaze was recorded by means of an infra-red eye tracker. The task was administered at three time-points, i.e., before, right after, and 30 minutes after a 1mA, 10-minute long, anodal stimulation of the right-hemisphere circuits for attentional orienting. The anode was a small round electrode (2 cm diameters), while the return electrode was ring-shaped and placed around the anode. Methods: in three different sessions, each participant received anodal stimulation of the right posterior parietal cortex (PPC), right frontal eye fields (FEF), or a sham stimulation. The main outcome was the distribution of fixations on the horizontal axis, as well as, a time-based analyses of fixation patterns. Inter-individual variability was also considered by analyzing the effects of stimulation according to the individual baseline performance and asymmetry before brain stimulation. Results: We observed a trend for a leftward shift of attention after FEF stimulation which was influenced by the individual baseline level. The time-based analyses revealed a significant presence of pseudo-neglect (i.e., a tendency for early leftward orienting) during the first seconds of

exploration. Discussion: our study explored the effects of HD-tDCS to modulate behavioral performance in a naturalistic visuospatial task. Possible limitations as well as future directions (e.g., the benefits of an online approach and bi-hemispheric montages) are also discussed. Conclusion: our results add a piece of evidence towards a better understanding of the effects of tDCS on overt orienting of attention and attentional asymmetries, taking into accounts important aspects linked to inter-individual variability.

Dyadic Interpersonal Interactions: a Dual-EEG Study

Michelangelo Dini, B. Ghezzi, A. Averna, N. Maiorana, M. Guidetti, A. Priori, T. Bocci, R. Ferrucci

Abstract

Objective: to investigate the correlation between neurophysiological synchronization and psychological characteristics in healthy dyads. Materials: Twenty healthy subjects (aged 23-58) were recruited in this study, they were randomly assigned into 10 dyads (female/female=2; male/male=4; female/male=4). Electroencephalography (EEG) was recorded from both participants simultaneously and continuously using two 64-channel EEG systems. Eysenck Personality Inventory (EPI) and Interpersonal Reactivity Index (IRI) were administered to evaluate psychological profile. Method: Simultaneous dual EEG was recorded with eyes closed and with eyes open. EEG oscillatory component of the signal based on interindividual coherence (through the Envelope of Imaginary Coherence or EIC) and correlation (through the Amplitude Envelope Correlation or AEC) were analyzed. Psychological indices of each dyad were created by calculating the difference in absolute value between the normalized individual scores of the partners (similarity index: lower scores indicate greater similarity) and correlated with neurophysiological findings. Results: Based on dyadic similarity index, we highlight a significant correlation between EEG synchronization and IRI similarity index when participants interacted with both eyes open ($p<0.001$, beta=-0,109) and closed ($p=0.041$, beta=-0,245). We found a correlation with EPI similarity index, but only in the 'eyes open' condition ($p<0.001$, beta=0,214). Discussion: Our results show that the correlation between the electrophysiological synchronization and the psychological indices depends to the level of similarity between partners. Conclusion: Simultaneous dual EEG could further improve the knowledge about processes occurring during dyadic interpersonal interactions.

Functional MRI correlates of face-name associative memory task with emotional stimuli in individuals with subjective cognitive decline

Alessandra Dodich, N. Canessa, G. Santi, C. Crespi, S. Iannaccone, A. Marcone, M. Zamboni, A. Falini, C. Cerami

Abstract

Background and Objective: Reduced performance at face-name associative memory (FNAM) tasks has been described in individuals with subjective memory decline (SMD), a clinical syndrome among older adults that has become of interest since its association with an increased risk of cognitive impairment and dementia. In this study, we aimed at evaluating pattern of brain functional connectivity during FNAM performance in SMD subjects. Materials and Methods: We measured brain activation during a fMRI task (FNAM) in 37 SMD individuals (22 male; age: 67.68Â±4.78; education: 15.49Â±4.37) classified according to the score at the Everyday Memory Questionnaire (EMQ). The associative memory-encoding task included three different conditions with participants asked to learn names associated with neutral, angry or fearful faces. Global and single emotion performances were recorded. SMD subjects were stratified by recruitment setting either from memory clinic (SMDclin) or community center (SMDcommu). FMRI data has been analysed in order to evaluate brain activity during learning and recall conditions of FNAM task. Results: Analysis of functional brain activity during learning and recall phases showed a bilateral activation of hippocampal structures, prefrontal cortex and temporal lobe. In addition, we found specific activation of limbic system during presentation of faces expressing negative emotions. Conclusions: Our study showed significant

differences in brain activation linked to implicit processing of affective stimuli in a learning task, supporting previous evidence on the relationship between emotion and cognition in old adults. Future studies may be focused on investigating the behavioural and neural response in patients characterized by socio-cognitive impairments. References: Horn MM, Kennedy KM, Rodrigue KM. Association between subjective memory assessment and associative memory performance: Role of ad risk factors. Psychol Aging. 2018 Feb;33(1):109-118. Sperling RA, Bates JF, Cocchiarella AJ, Schacter DL, Rosen BR, Albert MS (2001) Encoding novel face-name associations: A functional MRI study. Hum Brain Mapp 14, 129â€“139. Rentz DM, Amariglio RE, Becker JA, Frey M, Olson LE, Frishe K, Carmasin J, Maye JE, Johnson KA, Sperling RA (2011) Face-name associative memory performance is related to amyloid burden in normal elderly. Neuropsychologia 49, 2776â€“2783.

The Role of Premotor Areas in Joint Action Motor Inhibition

Elisa Dolfini, P. Cardellicchio, A. Casarotto, L. Fadiga, A. D'Ausilio

Abstract

Behavioural coordination, during Joint Action (JA), requires sensorimotor communication flowing between agents in order to smoothly negotiate and adjust actions in time and space (Sebanz et al., 2006). Thus, inhibitory motor control must play a key role when the motor system has to integrate inferences about othersâ€™ action and plan appropriate coordinative responses (Cardellicchio et al., 2020a). To date, little research has been carried out on JA motor inhibition in general and, more in particular, on the modulatory role that premotor areas might play in JA inhibitory control. Here we used an interactive task in which subjects were required to reach the cap of a bottle and open it unimanually (as in Cardellicchio et al., 2020b). The bottle was held and stabilized by a co-actor (JA) or by a mechanical holder (vice clamp, no-JA). Replicating our previous study, we recorded two TMS-based indexes of inhibition (short-interval intracortical inhibition â€“ sICI; cortical silent period length - cSP), during the reaching phase of the task. These two indexes respectively reflect fast intracortical (GABAa-mediated) and slow corticospinal (GABAb-mediated) inhibitions. To analyse the contribution of the lateral premotor cortex we designed a three session experiment in which, by means of a continuous Theta Burst Stimulation (cTBS), we interfered with the dorsal premotor cortex (PMd), the ventral premotor cortex (PMv) or a control site (vertex). Analyses on sICI showed unspecific reduction of intracortical inhibition in JA for all the stimulation sites. Instead, the cSP length was clearly affected by the different cTBS stimulations. As expected, the control condition (TMS on vertex) confirmed longer cSP in JA. After the stimulation of the two premotor cortices, we observed a reduction of cSP length in JA with respect to the control site. Conversely, longer cSPs in no-JA only after PMd stimulation emerged. These results confirm a clear dissociation between fast and slow inhibition during JA (Cardellicchio et al., 2020b) and add evidence that premotor areas may play a role in driving corticospinal inhibitory mechanisms, essential to JA coordination. Specifically, we suggest that PMd could be the origin of the modulatory drive sculpting movements according to the socio-interactive context. References: Sebanz, N., Bekkering, H., & Knoblich, G. Joint action: bodies and minds moving together. Trends in cognitive sciences, 2006, 10(2), 70-76. Cardellicchio, P., Dolfini, E., Hilt, P. M., Fadiga, L., & Dâ€™Ausilio, A. Motor cortical inhibition during concurrent action execution and action observation. NeuroImage, 2020a, 208, 116445. Cardellicchio, P., Dolfini, E., Fadiga, L., & D'Ausilio, A. Parallel fast and slow motor inhibition processes in Joint Action coordination. Cortex, 2020b, 133, 346-357.

The Risk of Lying: anterior insular/cingulate modulations of dishonest decision-making under the risk of losing one's reputation

Lennie Dupont, V. Santangelo, M. S. Panasiti, R. T. Azevedo, S. M. Aglioti

Abstract

One overlooked factor in deceptive decision-making neuroimaging research is how the risk of being caught in the act of lying modulates the brain areas compared to making such decisions anonymously. This study

aimed to explore the regions corresponding to dishonesty under the risk of losing one's reputation using a Temptation to Lie Card Game during fMRI. This paradigm allowed us to study the brain areas linked to spontaneous lies and truths for either self-gain or other-gain reasons during a reputation risk and an anonymous condition. We found that regardless of the condition, the most active regions during spontaneous lies compared to truths were - as expected frontal regions, specifically the anterior cingulate cortex (ACC) and anterior insula (AI), bilaterally. Interestingly, the region that was significantly more active during spontaneous lies in the risky condition was the ventromedial portion of the left AI (vmAI). More specifically, making risky self-gain lies increases the activity in left vmAI and bilateral ACC compared to risky other-gain truths, while in the anonymous condition it is the other way around. Correlation analyses showed that the more an individual is rated manipulative the less the left ACC was active during risky self-gain lies. Connectivity of the left vmAI is stronger with the right dorso-medial prefrontal cortex during self-gain lies in risky conditions vs. anonymous conditions. Overall, these findings highlight for the first time a key role played by the vmAI/ACC circuit to modulate dishonest decision-making in terms of social risk. References: Panasiti, M. S., Pavone, E. F., Merla, A., & Aglioti, S. M. (2011). Situational and Dispositional Determinants of Intentional Deceiving. PLOS One, 6(4), 2-7. Sip, K. E., Skewes, J. C., Marchant, J. L., McGregor, W. B., Roepstorff, A., & Frith, C. D. (2012). What if I get busted? Deception, choice, and decision-making in social interaction. Frontiers in Neuroscience, 6(APR), 1-10 Christ, S. E., Van Essen, D. C., Watson, J. M., Brubaker, L. E., & McDermott, K. B. (2009). The contributions of prefrontal cortex and executive control to deception: Evidence from activation likelihood estimate meta-analyses. Cerebral Cortex, 19(7),

Enhanced alpha-band frontoparietal connectivity facilitates the suppression of irrelevant information during a working memory task

Giulia Ellena, J. Macedo-Pascual, J. Trajkovic, P. Di Luzio, C. Poch, V. Romei

Abstract

Aims: A network of frontoparietal areas is known to be involved in working memory functions (WM). Frontoparietal synchronization of alpha oscillations is associated with an active inhibitory mechanism that suppresses irrelevant information, to facilitate prioritization of the to-be-remembered, information [1]. This study aims to evaluate the involvement of frontoparietal alpha-connections in WM task performance, by enhancing alpha-tuned frontoparietal connectivity with a novel cortico-cortical paired associative stimulation protocol (ccPAS) [2]. The enhanced connectivity should result in a more efficient suppression of items presented contralateral to the stimulation site allowing a more efficient prioritization of the ipsilateral items. Materials and Methods: ccPAS consisted of 90 pairs of TMS pulses delivered over the right frontoparietal network every 10 seconds with a delay between frontal and parietal site set to the duration of an individual alpha cycle. 72 healthy participants divided into three groups performed a change detection WM task before (BSL) and 30 minutes after (T30) the ccPAS. ccPAS could follow an anterior-posterior direction (Frontoparietal Group), a posterior-anterior direction (Parietofrontal Group) or sham (Sham Group) stimulation. Analysis of functional connectivity was performed using the weighted phase lag index (WPLI). Results: Results revealed a significant impact of stimulation on WPLI and WM performance as a function of the group. Specifically, enhanced connectivity for clusters of the frontoparietal electrodes at T30 relative to BSL was found in the Frontoparietal Group. Such effect was specific to the alpha-band, as no significant WPLI modulations could be observed in control bands (i.e. theta). Moreover, WM performance improved for items ipsilateral to the stimulated hemisphere. Crucially, this enhanced connectivity positively correlated with the enhanced WM performance, and exclusively for trials in which the irrelevant information was contralateral to the stimulated hemisphere. No significant WPLI modulations, nor a significant change in WM performance was observed between BSL and T30 when controlling for stimulation directionality (Parietofrontal Group) or sham stimulation (Sham Group). Discussion: Behavioural and physiological results confirm the involvement of the alpha-oscillatory frontoparietal network in task-related suppression demands. Frequency- and direction-specific ccPAS effects demonstrate that oscillatory-tuned timing and direction of stimulation are critical in modulating frontoparietal connectivity and

performance in a working memory task. Conclusions: We provide here the first causal demonstration of selective modulation of oscillatory functional frontoparietal connectivity serving suppression of irrelevant information in WM performance. References: [1] de Vries, I. E., Slagter, H. A., & Olivers, C. N. (2020). Oscillatory control over representational states in working memory. Trends in Cognitive Sciences, 24(2), 150-162. [2] Romei, V., Thut, G., & Silvanto, J. (2016). Information-based approaches of noninvasive transcranial brain stimulation. Trends in Neurosciences, 39(11), 782-795.

Huntingtin gene intermediate alleles influence the progression from Subjective Cognitive Decline to Mild Cognitive Impairment: a 15-year follow-up study

Filippo Emiliani, S. Mazzeo, C. Polito, S. Bagnoli, M. Mattei, S. Padiglioni, V. Berti, G. Lombardi, G. Giacomucci, M. De Cristofaro, A. Passeri, C. Ferrari, B. Nacmias, S. Sorbi, V. Bessi

Abstract

OBJECTIVES: The Huntingtin gene (HTT) contains a key region of CAG repeats. When expanded beyond 39 repeats, Huntington disease develops. CAG expansions ranging from 27 to 35 repeats are termed as intermediate alleles (IAs). Previous studies reported a higher frequency of IAs in AD patients. We aimed to assess the effect of IAs on progression from SCD to MCI. METHODS: We considered 126 consecutive patients self-referred to our center diagnosed with SCD. At baseline, all patients underwent an extensive neuropsychological assessment, APOE genotyping and analysis of HTT alleles. From the initial sample we excluded: nine patients diagnosed with psychiatric or neurodegenerative diseases other than AD; eleven patients who did not progress to MCI within a follow-up shorter than 10 years. We finally included 106 SCDs. RESULTS: Eleven out of 106 patients (10.38% [95%CI 4.57-16.18]) were carriers of intermediate alleles (IAs+). IAs+ had more frequent family history of AD than IAsâ€“(50.00% [95%C.I.=39.89-60.11] vs. 90.91% [95%C.I.=73.92-100], p=0.001, V=0.251). During the follow-up, 44 out of 106 patients (41.51% [95%C.I.=32.13-50.89]) progressed to MCI (p-SCD), while 62 patients (58.49% [95% C.I.=49.11-67.87]) did not (np-SCD). A multivariate Coxâ€™s regression analysis showed that IAs, age at baseline, and APOE É›4 had a significant effect on progression from SCD to MCI. In particular, IAs showed hazard ratio of 2.35 (95% C.I.=1.03-5.34). We dichotomized age at baseline using a cut-off of 60 years (<60 = younger patients [YP], >60 = older patients [OP]) and classified patients into four groups: YP/IAsâ€“, YP/IAs+, OP/IAsâ€“ and OP/IAs+. OP/IAs+ had a higher proportion of progression from SCD to MCI (85.71% [95%C.I.=59.79-100]) as compared to YP/IAsâ€“ (28.57% [95%C.I.=13.60-43.54], Ï‡2=13.91, p<0.001) and OP/IAsâ€“ (45.00% [95%C.I.=32.41-57.59], Ï‡2=10.12, p=0.001). We classified patients according to APOE and IA status as: É›4â€“/IAâ€“, É›4â€“/IA+, É›4+/IAâ€“, É›4+/IA+. Proportion of progression in É›4+/IA+ group (100%) was higher as compared to É›4â€“/IAâ€“ (33.33% [95%C.I. =21.96-44.71]) and É›4+/IAâ€“ (55.56% [95%C.I.=36.81-74.30], Ï‡2 = 4.60, p=0.032). DISCUSSION: SCDs who were carriers of IAs had a two-fold higher risk of progression to MCI as compared to non-carriers. IAs interact with two well-recognized risk factors of cognitive decline (age and APOE É›4) increasing the risk of progression to MCI in SCD patients older than 60 years and carriers of APOE É›4. CONCLUSIONS: Our results may suggest a role of HTT IAs in the continuum from SCD to MCI, adding an important piece to the puzzle of genetic factors involved in cognitive decline.

Dopaminergic medication enhances subjective enjoyment and improves interactive performance during dyadic motor interactions in patients with Parkinson's Disease

Vanessa Era

Abstract

Objectives: Flexible behaviour is essential for effective interpersonal motor interactions. In these scenarios, individuals need to predict and monitor their partner actions by continuously updating their expectations about them. It has been recently proposed that the dopaminergic system would support individual flexible

behaviour. However, its role in supporting the ability to flexibly adapt oneâ€™s own motor behaviour to that of another individual during interpersonal motor interactions has never been explored. To address this issue, we tested patients with Parkinsonâ€™s Disease (PD, as a model of dysfunctional dopaminergic system) in a motor interaction task. PD patients were tested in â€œOffâ€• (in suspension of dopaminergic medication) and â€œOnâ€• medication (regularly taking their dopaminergic medication) along with a group of healthy controls (HCs). Materials: Participants were asked to synchronize their grasping movements with those of a virtual partner (Joint-Grasping Task), as explained below. Methods: 15 PD patients were tested in â€œOnâ€• and â€œOffâ€• medication conditions. A group of 15 healthy controls matched for years and education was also included. Participants were required to grasp a bottle-shaped object (that could be grasped in two different parts, i.e., an upper or a lower part via a precision and a power grip, respectively) as synchronously as possible with a virtual partner in two separate conditions, namely: 1) a Cued condition, in which participants knew in advance where they had to grasp the object and, 2) an Interactive condition, asking participants to coordinate their action according to the virtual partner's movement as to imitate or complement its movement (thus requiring on-line prediction and monitoring of the virtual partnersâ€™ actions). Results: The main result is that, compared to when in â€œOnâ€• medication and to healthy controls, PD patient in â€œOffâ€• medication achieved a worse performance in the Interactive condition, after controlling for their ability to perform the task in the Cued condition, and found the interaction less enjoyable. Dopaminergic medication improved patientsâ€™ ability to coordinate their actions with the virtual partner, as their performance in â€œOnâ€• medication did not differ from the one of HCs. Moreover, PD patients in â€œOnâ€• medication enjoyed the interaction more compared to themselves in â€œOffâ€• medication. Discussion: These results indicate a key role of the dopaminergic system in supporting the mechanisms necessary to flexibly adapt oneâ€™s own motor behaviour to a partnerâ€™s action during motor interactions.

Emotional facial expressions affect inhibitory control only when they are task-relevant

Luca Falciati, C. Mancini, C. Maioli, G. Mirabella

Abstract

The ability to integrate emotional information with ongoing cognitive processes is critical to generate appropriate behaviors, especially in social contexts. In particular, facial emotional expressions are highly relevant for social interactions, as they could trigger either defensive or approaching responses. These reactions are modulated by inhibitory control, which plays the crucial role of preventing the execution of impulsive and inappropriate responses. Although there is a consensus around the fact that emotional information affects motor behavior, the study of the impact of facial emotional expressions on inhibition leads to contrasting findings. In our view, a crucial confounding factor that can explain such inconsistencies is the task-relevance of the emotional content of the stimuli. To clarify this issue, we compared the effect on inhibitory control of the same set of facial expressions in two different experimental versions of a Go/No-go task. Forty subjects were recruited for the study. In one version of the task (Emotional Go/No-go task), they had to execute a reaching movement whenever a neutral face was shown and refrain from moving in the presence of an emotional facial expression (fear or happiness). In the other version of the task (Gender Go/No-go task), participants were instructed to withhold their movements when pictures of a given gender were presented, thus, irrespectively of the faces' emotional expression. In Emotional Go/No-go task, data show that the capability of refraining from actions is significantly more impaired after the presentation of happy faces than after the presentation of fearful faces. Conversely, in the Gender Go/No-go task this effect disappears. In this study, for the first time, we tested the impact of task-relevance of the same stimuli on the inhibitory control of the same type of movements net of other confounding factors (e.g., differences in arousal, conflating motor responses with emotional valence of the stimuli). We found a clear-cut result: inhibitory control is affected only when emotional expressions are task-relevant. Therefore, facial emotions do not influence behavioral responses automatically. Instead, they would do so only when they are intrinsically relevant for ongoing goals.

The role of motor information and rational thinking in interpersonal coordination

Martina Fanghella, C. Colombo, M. Pascarelli, F. Guala, C. Sinigaglia

Abstract

The goal of our study is to investigate the role of motor cues versus rational thinking in driving interpersonal coordination. Previous literature have shown that we use motor representations to understand othersâ€™ behaviour (Rizzolatti & Sinigaglia, 2016). However, according to standard rational decision theory, agents in a strategic interaction should expect other players to act rationally (Gold and Sudgen 2007; Guala 2018). What if those two cues â€“ motor information and rational thinking â€“ are conflicting when we must predict and accordingly adjust with our partnerâ€™s behaviour? In this study, we aimed at exploring how participants engaged in a cooperative game with a (fictional) partner, who could either behave rationally (choosing a high reward) or irrationally (choosing a low reward). Participants were instructed to achieve coordination with their partner in order to obtain a monetary reward, based on choosing the same type of reward (high or low). Importantly, Player 1 (the participant) could observe on his/her screen a video showing a portion of a grasping movement (10%, 20%, 30%, 40%). Players 1 were told that the action displayed during each round of the game was a real-time reconstruction of Playerâ€™s 2 (the fictional partner) grasping movement toward an object associated with high or low reward (a large or a small ball). The 2*2*4 mixed-repeated measures ANOVA (Experiment*Dimension*Duration, p=.039) showed that, when the large ball was associated with high reward, participants were more successful in coordinating for the 20% (p=.014), 30% (p=.000), and 40% (p=.000) durations when Player 2 grasped a large ball. Conversely, when the small ball was associated with high reward, participants were more coordinated in 10% (p=.000) and 20% (p=.001) durations when Player 2 chose the small ball. Interestingly, our results show that, for low motor information, participants had a bias towards the small ball when it was associated with high, but not low reward; conversely, for high motor information, participants had a bias towards the large ball when it was associated with high, but not low reward. Our study is novel in investigating the role of motor information and rational thinking in shaping predictions on othersâ€™ behaviour and achieving interpersonal coordination. We showed that these two types of information might both contribute to individualsâ€™ strategy, specifically, rational thinking might have a primary role when the motor information is insufficient to make a judgment, while motor cues are used preponderantly when they can actually reveal information on our partnerâ€™s action. References: Rizzolatti, G., & Sinigaglia, C. (2016). The mirror mechanism: A basic principle of brain function. Nature Reviews Neuroscience, 17(12), 757â€“765. https://doi.org/10.1038/nrn.2016.135 Gold, N., & Sugden, R. (2007). Collective Intentions and Team Agency. The Journal of Philosophy, 104(3), 109â€“137. Guala, F. (2018). Coordination, Team Reasoning, and Solution Thinking. Revue dâ€™economie Politique, Vol. 128(3), 355â€“372.

Effects of Transcranial Direct Current Stimulation (tDCS) on visuospatial attention

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Abstract

The coupling of opposite effects of anodal-excitatory and cathodal-inhibitory tDCS is well established in the sensorimotor domains, but evidence is more controversial for higher cognitive functions. The aim of our study is to investigate the effectiveness of tDCS in modulating visuospatial attention and whether the direction of the modulation is opposite between the two polarities. 55 right-handed students participated in a two-session experiment in which they received either anodal or cathodal stimulation and sham, in counterbalanced order. The target electrode (9cm2) was placed on the right posterior parietal cortex (P2 according to the 10-20 International EEG System), while the reference electrode (25cm2) was placed over the contralateral supraorbital area. Stimulation was delivered at an intensity of 0.7 mA for 15 minutes in the real condition and for 30 seconds in the sham condition. During the stimulation participants performed two computerized tasks in counterbalanced order: a Posner Cueing Task (PCT) and a Visual Short-Term

Memory Task (VSTMT). Accuracy and reaction times (RT) were recorded. The analyses were carried out using a mixed model, inserting the intercept of the subjects as a random variable. In the PCT, the stimulation condition did not affect accuracy, that only differ between valid and invalid cue condition, as expected. Analyzing RTs, we found an interaction between the stimulation condition and the validity of the trials ($F(2) = 11.27$, $p<.001$). In the valid cue condition, cathodal stimulation increased RTs while the anodal stimulation showed a tendency to reduce them compared to the sham condition. Interestingly, in the invalid cue condition, both the anodal and the sham stimulation followed the typical PCT behavioral pattern, with attentional costs in terms of slowing down the RTs. Conversely, this trend was not detected for cathodal stimulation, in which faster RTs were recorded. In the VSTMT, we did not find any effect of tDCS or validity on accuracy (all ps > 0.56). Our findings, although preliminary, seem to suggest a dissociation between the behavioral effects of anodal and cathodal stimulation on spatial attention, which are in line with results in the sensorimotor domain.

Interplay between emotion and decision-making: the role of gender

Eleonora Fiorenzato, P. Bisiacchi, G. Cona

Abstract

Would you prefer to receive 120â,¬ now or 400â,¬ in one year? These decisions are prevalent in our everyday life and require trade-offs between immediate-small and later-larger rewards. This is known as delay discounting task (DDT). Numerous studies highlighted the crucial role of emotions in modulating decision-making, as indeed confirmed by their underlying and overlapping brain networks1. However, previous findings related to emotional valence (positive vs. negative) led to contradictory results and only few studies considered the potential influence of gender. Our aim was to explore whether specific induced emotions modulate monetary decision-making and their interplay with gender, given the established gender differences in both emotional and cognitive processing. Here, we present data from 306 individuals (Mage=33.71Â±14.38, 194/112 females/males), who completed a web-based experiment consisting of an initial Qualtrics-survey to collect sociodemographic information and the presentation of a validated emotional movie followed by the DDT. In the last part, emotional-psychological tests were administered to measure arousal/pleasantness levels, impulsive traits, and psychological well-being. Concerning the validated emotional movies2, three categories were considered â€“ negative, positive and neutral â€“ which were randomized across participants. The DDT area under the curve (AUC) was calculated3, as behavioral indicator of discounting rate, with smaller AUC reflecting more impulsive decision-making. Our results showed that women were more inclined to choose the immediate but smaller rewards (0.32Â±0.23) when a negative emotional state was induced (i.e., fear) as compared to men, who were more prone to select the delayed but larger rewards (0.54Â±0.25; $p<0.001$) â€“ while controlling for age and psychological disorders effect. Whereas no differences in discounting rates were observed when positive and neutral emotional states were induced. Across emotional conditions, we found no differences in terms of psychological symptoms, impulsivity, and pleasantness levels, except for the arousal level that was higher in the negative (66.46Â±21.22) than in the neutral condition (56.85Â±25.61; $p=0.012$). Overall, we found gender differences in psychological symptoms (DASS-21), with women reporting higher stress and anxiety levels (35.43Â±21.82) as compared to men (30.34Â±18.12; $p=0.012$). These findings suggest that the interplay between emotional valence and gender has a significant influence on decision-making, namely negative emotional state led the female group to choose the immediate-small rewards as opposed to men, who selected the later-larger rewards. Hence, a negative-stressed emotional state can induce to the adoption of different decision-making strategies as a function of gender, with women presenting with greater impulsive behaviors and reduced auto-control than men in negative conditions.

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Delivering midfrontal theta-tACS to modulate intertemporal decision conflicts: an In-Principle-Accepted (IPA) Registered Report

Gabriele Fusco, M. Scandola

Abstract

Each choice involves a decision. Each decision reflects a detailed evaluation process of multiple elements that lead organisms to prefer the best solution among two or more alternatives. To provide the optimal choice, avoid errors, and produce an appropriate behavior, the brain requires the efficiency of a specialized system capable of organizing different levels of analysis. Cognitive control is an integrated high-order function that processes this complex computation trough error detection and conflict monitoring, facilitating decision-making and goal attainment (1). EEG studies (2) have shown that during conflict processing of cognitive representations, a rhythmic oscillatory activity in theta rhythm, named midfrontal theta (MFÏ´), increases over the medial frontal cortex (MFC). MFÏ´ may index the temporal dynamics of different brain areas, operating as a synchronizer during the request of control. However, it remains to understand whether MFÏ´ is an active mechanism capable to communicate detailed information to the distal areas involved in decision-making during top-down control or just an epiphenomenon generated by different processes that occur within the brain. The transcranial Alternating Current Stimulation (tACS) might solve such an issue by entraining neural networks acting on the behavioural performance in a frequency-dependent manner (3). The present within-subject, sham controlled, cross-over study, aims at exploring the tendency to choose between economic offers in a Temporal Discounting paradigm during theta, gamma, and sham tACS, with the goal of modulating reaction times (RTs) and choice preferences when different levels of conflict (i.e., low, medium, high), induced by combining specific delays and payoffs, occur. Hypothesis testing, sample size estimate and analysis of pilot results have been conducted using Bayesian statistics. The pilot study conducted on 14 healthy participants showed a significant interaction between tACS frequency and conflict level. Specifically, participants selected more small sooner rewards (impulsive preferences) rather than larger later rewards during high conflict processing and while receiving midfrontal theta-tACS compared to sham. No effects on RTs have been observed. The possibility to modulate intertemporal choices with non-invasive methods may inform theories of how neural oscillations causally influence impulsive and controlled behaviour and decision processes in everyday life. The study received a priori peer-review (1 Stage) and In-Principle-Acceptance (IPA) as a Registered Report (RR) from the Cortex Journal (https://osf.io/x52vm/). The RR is a new scientific format that meets the rigorous standards of the Open Science. This innovative approach aims at reducing publication biases and p-hacking, and therefore, improving replicability in science. References: Botvinick, M. M., Braver, T. S., Barch, D. M., Carter, C. S., & Cohen, J. D. (2001). Conflict monitoring and cognitive control. Psychological review, 108(3), 624. Cavanagh, J. F., & Frank, M. J. (2014). Frontal theta as a mechanism for cognitive control. Trends in cognitive sciences, 18(8), 414-421. Antal, A., & Paulus, W. (2013). Transcranial alternating current stimulation (tACS). Frontiers in human neuroscience, 7, 317.

Sex differences in repetition-based rule learning: a meta-analysis of fNIRS language studies

Jessica Gemignani, J. Gervain

Abstract

Objectives: Infantsâ€™ ability to perceive repetition-based regularities is thought to play a central role in the process of language acquisition and has been long investigated, both with behavioral and with neuroimaging studies, in particular with functional near-infrared spectroscopy (fNIRS) (De la Cruz-Pavia and Gervain, 2021). In this work, we aim at exploring whether this mechanism exhibits sex differences and to assess the variability of its effect size across age groups and brain regions. Materials: Seven fNIRS studies

conducted in three different labs were examined; the sample comprised data acquired from 150 infants (72 M, 78 F; 91 newborns, 59 six month-olds). Stimuli included trisyllabic auditory sequences in the form of AAB or ABB as well as random sequences. fNIRS was measured with 24 channels distributed bilaterally. Details on the stimuli or the arrangement of optodes can be found in Gervain et al. (2008). Methods: Data analysis included pre-processing and block-averaging; then, Cohenâ€™s d effect sizes were computed as the differences between the hemodynamic responses elicited by (i) repetition sequences and random sequences (R>N); (ii) repetition sequences and the baseline (R>0); (iii) random sequences and the baseline (N>0). For each of the three comparisons, the variability of the effect sizes was evaluated across studies with a meta-analytic approach, as well as across subjects with mixed-effects models. Effect sizes were averaged across channels covering the bilateral temporal and frontal areas. Results: For the R>N comparison, in the left temporal ROI, the estimated d was 0.21 (C.I [-0.30, â€“ 0.72]) in newborns and -0.02 (C.I. [-0.38, 0.34]) at six months; for R>0, d was 0.31([-0.12, 0.74]) in newborns and 0.12([-0.24, 0.48]) at six months; for N>0, d was 0.14([-0.15, 0.44]) in newborns and 0.14([-0.22, 0.50]) at six months. For neither of the three comparisons was the effect of sex statistically significant. Discussion and conclusions: Despite the variability normally displayed by data acquired in developmental populations, the effect of repetition-based regularities on the infant brain as measured with fNIRS is robust and reproducible, and it does not display sex differences, neither at birth or at six months.
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VENERDI' 1 OTTOBRE 2021

POSTER

Gender differences in cognitive reserve: implication for Subjective Cognitive Decline in women

Giulia Giacomucci, S. Mazzeo, S. Padiglioni, J. Balestrini, S. Bagnoli, L. Bracco, B. Nacmias, S. Sorbi, V. Bessi

Abstract

Subjective Cognitive Decline (SCD) is as a self-experienced decline in cognitive capacity with normal performance on standardized cognitive tests and has been shown to increase risk of Alzheimerâ€™s Disease (AD). Several studies applying multifactorial approaches found that demographic features, genetic factors and cognitive reserve may influence the risk of progression to MCI and dementia. Sex, which has been associated to AD, seems to have a role also on SCD prevalence. Gender differences in cognitive reserve have been previously described in AD patients. The aim of our study was to investigate gender differences in cognitive reserve evaluating how sex might modulate the role of cognitive reserve on SCD. We included 381 SCD patients who referred to our center between January 1994 and August 2020. All patients underwent clinical evaluation, neuropsychological assessment, evaluation of premorbid intelligence by the Test di Intelligenza Breve (TIB), evaluation of cognitive complaints by the Memory Assessment Clinics-Questionnaire (MAC-Q), depressive symptoms by Hamilton Depression Rating Scale (HDRS), and Apolipoprotein E (APOE) genotyping. Proportion between women and men was significantly different (68.7%, 95% C.I. 63.9â€“73.4 vs 31.4%, 95% C.I. 26.6â€“36.0). Women were younger than men at onset of SCD and at the baseline visit (p=0.02), had lower years of education (p=0.007), lower TIB scores (p<0.001), higher HDRS (6.3Â±4.1 vs 5.12Â±3.8, p=0.007) and MAC-Q scores (26.3Â±3.1 vs 25.0Â±2.7, p=0.012). Multivariate analysis showed that sex influences TIB independently from years of education and other confounding factors. TIB was directly associated with age at onset of SCD both in women and in men,

while years of education was inversely associated with age at onset only in women. TIB was directly associated with MAC-Q in men. Premorbid intelligence was associated with both age at onset and severity of cognitive complaints in men. Surprisingly, premorbid intelligence and education had an opposite effect on age at onset of SCD in women. Education might act as a minor contributor of cognitive reserve in women but not in men [2]. Other factors with an already known gendered effect on brain [3] might have a stronger role in accumulation of cognitive reserve in SCD women. Sex might modulate the effect of cognitive reserve on SCD. The understanding of such sex differences and complexities is pivotal for integrating reserve capacity into personalized medicine approach for risk prediction and potential treatment options of AD. References: Jessen F., Amariglio R.E., van Boxtel M., Breteler M., Ceccaldi M., ChÃ©telat G., Dubois B., Dufouil C., Ellis K.A., van der Flier W.M., et al. (2014). A conceptual framework for research on subjective cognitive decline in preclinical Alzheimerâ€™s disease. Alzheimers Dement. J. Alzheimers Assoc. 10, 844â€“852 Wilson RS, Yu L, Lamar M, Schneider JA, Boyle PA, Bennett DA (2019). Education and cognitive reserve in old age. Neurology 92:e1041â€“e1050. https://doi.org/10.1212/WNL.0000000000007036 Subramaniapillai S., Almey A., Natasha Rajah M., Einstein G. (2020) Sex and gender differences in cognitive and brain reserve: Implications for Alzheimer's disease in women. Front Neuroendocrinol. 60:100879. doi: 10.1016/j.yfrne.2020.100879.

Linguistic task-induced changes in motor cortex excitability in Italian Sign Language (LIS) signers: preliminary data

Fabio Giovannelli, A. Borgheresi, G. Lucidi, M. Squitieri, A. Suppa, A. Berardelli, M. Viggiano, M. Cincotta

Abstract

Objective. A substantial body of studies using transcranial magnetic stimulation (TMS) supports the hypothesis of a functional link between the brain areas mediating language processes and the motor system. In healthy subjects, reading aloud facilitated the corticospinal excitability as revealed by the increase in the motor evoked potential (MEP) size recorded in the muscles of the dominant hand (Meister et al., 2003; Bracco et al., 2009; Suppa et al., 2015). This effect was specific for the dominant hand area of the primary motor cortex (M1) and absent in the non-dominant hand or in leg muscles. It has been hypothesized that this linguistic task-induced modulation of the M1 excitability may reflect the role of manual gestures in the evolution of human language. According to this hypothesis, it is conceivable that in healthy individuals who use sign language for communication this cortical excitability modulation could be rearranged. The aim of this study was to evaluate the effect of linguistic tasks on the excitability of the M1 in a group of healthy signers. Material and methods. Ten healthy right-handed Italian Sign Language (LIS) signers (8 interpreters and 2 hearing individuals who acquired LIS from their deaf parent) participated to the study. Single-pulse TMS was applied to either M1 hand area at the baseline and during different linguistic and non-linguistic tasks: 1) reading aloud of single words; 2) silent reading; 3) oral movements without vocalization; 4) producing simple syllabic phonation; and 5) looking at meaningless non-letter strings (control condition). Results. MEPs elicited by TMS of the dominant M1 were significantly larger during either reading aloud and silent reading (150% and 131% baseline MEP amplitude) compared to control condition (88%). Differently from data reported in previuos studies (Meister et al., 2003; Bracco et al., 2009; Suppa et al., 2015), a MEP amplitude enhancement emerged also when TMS was applied to the non-dominant M1 during â€˜linguisticâ€™ tasks (144% and 139% for reading aloud and silent reading conditions, respectively). Discussion/Conclusions. These preliminary results suggest that in healthy LIS signers, who use bimanual gestures to communicate, the functional connectivity between the brain network mediating language processes and the motor system may be remodulated and not specific for the dominant hemisphere. Data need to be confirmed by comparison with an 'ad hoc' control group. References: Bracco L, Giovannelli F, Bessi V, Borgheresi A, Di Tullio A, Sorbi S, Zaccara G, Cincotta M. Mild cognitive impairment: loss of linguistic task-induced changes in motor cortex excitability. Neurology. 2009;72(10):928-34. Meister IG, Boroojerdi B, Foltys H, Sparing R, Huber W, TÃ¶pper R. Motor cortex hand

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Brain networks in Alzheimer's Disease: a study of EEG resting-state functional connectivity

Fabrizio Guajana, V. Blandino, F. Graziano, E. Muscoso, T. Piccoli, G. Caravaglios

Abstract

Objective: To explore neurophysiological biomarkers of Alzheimerâ€™s disease (AD), we investigated electroencephalography of patients with mild cognitive impairment (MCI) due to AD, and assessed sLORETA functional independent component analysis, a measure of brain functional connectivity.â€¨ Methods: 115 patients with MCI due to AD and 70 healthy elderly (HE) were enrolled. Sixthy seconds of artifact-free EEG data were selected and compared between patients with MCI and HE. We applied the standard low resolution brain electromagnetic tomography-ICA (sLORETA-ICA) algorithm to resting-state EEG data to evaluate differences between healthy elderly and patients with MCI. Results: seventeen spatio-temporal patterns of connectivity were revealed as independent resting-state networks (RSNs); they were common to both groups and congruous with physiological assumptions that are topography and frequency of known networks. Statistical analysis showed that MCI patients used some networks differently than healthy subjects. In particular, in MCI patients, alpha spectral density was reduced at the level of the detected RSNs, whilst delta rhythm magnitude was enhanced. Beta oscillations showed a twofold pattern: for some RSNs it was reduced; in other cases, it was enhanced, probably reflecting a compensation mechanism. The results are in line with the hypothesis stating that the morphological and functional disconnection observed in the course of AD is the main mechanism responsible for the progressive decline in cognitive performance. Conclusions: the results indicate that, in MCI due to AD, sLORETA-ICA can detect EEG-RSN connectivity disruptions between certain brain regions; therefore, it may potentially represent a neurophysiological biomarker during the early clinical stage the disease. Significance: Our study indicated that MCI due to AD and healthy elderly had different patterns of EEG-RSN connectivity, as revealed by sLORETA-ICA. References: Albert, M.S., DeKosky, S.T., Dickson, D., Dubois, B., Feldman, H.H., Fox, N.C., Gamst, A., Holtzman, D.M., Jagust, W.J., Petersen, R.C., Snyder, P.J., Carrillo, M.C., Thies, B. and Phelps, C.H. (2011), The diagnosis of mild cognitive impairment due to Alzheimer's disease: Recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimer's & Dementia, 7: 270-279. https://doi.org/10.1016/j.jalz.2011.03.008 Masahiro Hata, Hiroaki Kazui, Toshihisa Tanaka, Ryouhei Ishii, Leonides Canuet, Roberto D. Pascual-Marqui, Yasunori Aoki, Shunichiro Ikeda, Hideki Kanemoto, Kenji Yoshiyama, Masao Iwase, Masatoshi Takeda, Functional connectivity assessed by resting state EEG correlates with cognitive decline of Alzheimerâ€™s disease â€“ An eLORETA study, Clinical Neurophysiology, Volume 127, Issue 2, 2016, Pages 1269-1278, ISSN 1388-2457, https://doi.org/10.1016/j.clinph.2015.10.030. Briels, C.T., Schoonhoven, D.N., Stam, C.J. et al. Reproducibility of EEG functional connectivity in Alzheimerâ€™s disease. Alz Res Therapy 12, 68 (2020). https://doi.org/10.1186/s13195-020-00632-3.

Electric field distribution in deep brain structures during transcranial direct current stimulation (tDCS) with cephalic and extracephalic montages: a computational study

Matteo Guidetti, F. Ragazzo, M. Dini, A. Averna, T. Bocci, A. Priori, A. Bianchi, M. Parazzini

Abstract

Objectives: To computationally compare the trend of electric field (E) distributions in 4 regions of interest (ROIs grey matter, hippocampus, thalamus and mid-brain) during transcranial direct current stimulation (tDCS) with cephalic and extracephalic montages. Materials: We estimated tDCS-induced E amplitude distribution inside the human head via a commercial software (Sim4Life V 6.0 - Zurich Med Tech). The

distribution of E was obtained by means of the equation: E = âˆ’âˆ‡Ï•. A realistic human model based on high-resolution MRI images of healthy volunteers were used â€“ the head model called â€œElla â€• (a 26-year-old female adult) [1]. Method: Sponge electrodes (Ïƒ = 1.4 S/m, 25 cm2, 1 mm of thickness) were modelled with a conductor (Ïƒ = 5.9 Ã— 107 S/m) over the surface and a uniform electrical potential (Â± 1 V). The following montages (according to 10â€“20 system) were tested: I) Anode over Cz, C3 and C4; cathode over Fp2; II) Anode over Cz, C3 and C4; cathode over right deltoid. As outcome variables, we considered: the â€œpeak â€• (99th percentile), the median, the 25th and 75th percentile of the E amplitude distribution in the ROIs; the percentage of area of hippocampus, mid-brain and thalamus where E amplitude was greater than 25% (V25), 30% (V30), and 50% (V50) of the peak in the grey matter for the same simulation. All the values considered were normalized to the 99th percentile of E in the grey matter for each montage. Results: For montage I), values reached in the grey matter were widely higher than deeper structures, where the normalized peak values were always lower than 30% of the cortical peak. Similar results were reached for percentual volumes; all the structures had V25 < 3%, V30 < 1.5%, and only thalamus had a V50 (V50 = 0.25%). Conversely, montage II) revealed values in the deep structures comparable to grey matters. Normalized peak values were around 70% of cortical ones, with hippocampus having higher percentual volumes (V25 = 100%, V30 = around 98%, V50 = around 40%). Discussion: Computational models have shown that tDCS (with cephalic montages) might induced E amplitude in deep structures; similarly, insights from transcutaneous spinal direct current stimulation (tsDCS) models have suggested that extracephalic montages might induce better results [2,3]. Here, we preliminarily support such insights. Conclusions: Our results suggest that tDCS with reference over deltoid might be further explore in the context of non-invasive deep brain stimulation (NDBS). References: 1. Christ A, Kainz W, Hahn EG, Honegger K, Zefferer M, Neufeld E, et al. The Virtual Family - Development of surface-based anatomical models of two adults and two children for dosimetric simulations. Phys Med Biol. 2010 Dec 17;55(2):23. Fernandes SR, Salvador R, De Carvalho M, Miranda PC. Electric FieldDistribution during Non-Invasive Electric and Magnetic Stimulation of the Cervical Spinal Cordâˆ—. In: Proceedings of the Annual International Conference of the IEEE Engineering in Medicine and Biology Society, EMBS. Institute of Electrical and Electronics Engineers Inc.; 2019. p. 5898â€“901. Parazzini M, Fiocchi S, Liorni I, Rossi E, Cogiamanian F, Vergari M, etal. Modeling the current density generated by transcutaneous spinal direct current stimulation (tsDCS). Clin Neurophysiol. 2014;125(11):2260â€“70.

Motor resonance flexibility to emotion-enriched context in Parkinson's disease patients with and without freezing of gait

Giovanna Lagravinese, A. Botta, G. Bonassi, R. Marchese, E. Pelosin, L. Avanzino

Abstract

Background. In healthy people, motor resonance mechanisms are flexible to negative emotional contextual clues with greater motor resonance during the observation of a reach to grasp movement performed in a context eliciting disgust. The link between emotional processing and motor control has become an interesting topic also in Parkinsonâ€™s disease (PD), where the association between emotional processing and behavioral outputs is evident in the phenomenon of freezing of gait (FOG).Aim. To study the response of the mirror neuron system, specifically motor resonance flexibility, to an emotion-enriched context in Parkinsonâ€™s disease. Materials and Methods. Cortico-spinal excitability of the left motor cortex was recorded in 44 participants, divided into 3 groups (10 PD patients with and 13 PD patients without freezing of gait and 21 age and gender-matched controls). Motor-evoked potential (MEPs) were recorded from a muscle involved in the grasping movement (i.e., abductor pollicis brevis, APB) while participants were watching the same reach-to-grasp movement embedded in contexts with negative emotional valence, but different levels of arousal: sadness (low arousal), and disgust (high arousal). Results. Basic motor resonance mechanisms were less efficient in PD than controls. Regarding responsiveness to emotional context, the video eliciting sadness evoked a similar motor resonance in PD and controls. Finally, responsiveness to

emotional contextual clues eliciting disgust was impaired in patients with PD. Discussion. Our findings show reduced motor resonance flexibility to disgust context. This finding supports the hypothesis that PD patients may have a deficit in â€œtranslatingâ€• an aversive motivational state into a physiologic response. In this scenario, a key role could be played by the amygdala, which is implicated in the appraisal of fearful stimuli and response to threatening situations. Conclusion. Given the fact that motor resonance implies oneâ€™s capacity to embody a representation of othersâ€™ actions, and that it likely contributes to several complex and crucial social skills, such as oneâ€™s understanding of othersâ€™ actions, intentions and emotions and the facilitation of interpersonal coordination and cooperation, the impaired motor resonance flexibility exhibited by PD may have an impact in patientsâ€™ quality of life. References: Lagravinese G, Bisio A, De Ferrari AR, Pelosin E, Ruggeri P, Bove M, Avanzino L. An Emotion-Enriched Context Influences the Effect of Action Observation on Cortical Excitability. Front Hum Neurosci. 2017 Oct 18;11:504. Gilat M, Ehgoetz Martens KA, Miranda-DomÃ-nguez O, Arpan I, Shine JM, Mancini M, Fair DA, Lewis SJG, Horak FB. Dysfunctional Limbic Circuitry Underlying Freezing of Gait in Parkinson's Disease. Neuroscience. 2018 Mar 15;374:119-132.

Deficits of hierarchical predictive coding in left spatial neglect

Stefano Lasaponara, M. Pinto, M. Pellegrino, F. Marson Assisi, M. Aiello, S. Campana, F. Tomaiuolo, F. Doricchi

Abstract

Aim: Right brain-damaged patients with unilateral spatial neglect fail to explore the left side of space. Recent EEG and clinical evidence suggest that neglect patients might suffer deficits in predictive coding (Lasaponara et al, 2018; 2021), i.e., identifying and exploiting probabilistic associations among sensory stimuli in the environment. To gain direct insights on this issue, we focused on the hierarchical components of predictive coding. Materials: Thirteen right-brain-damaged patients with left spatial neglect (N+), fourteen right-brain-damaged patients without neglect (N-) and sixteen age-matched healthy participants (HC) were included in the study. Methods: We recorded EEG responses evoked by central, left-side or right-side tones that were presented at the end of sequences of four central tones. Left-side and right-side deviant tones produce a pre-attentive Mismatch Negativity (MMN) that reflects a lower-order prediction error for the â€œLocalâ€• deviation of the tone at the end of the sequence. Higher-order prediction errors for the frequency of these deviations in the acoustic environment, i.e. â€œGlobalâ€• deviation, are marked by the P3 response (Bekinschtein et al., 2009). Results: We show that when neglect patients are immersed in an acoustic environment characterised by frequent left-side deviant tones, they display no MMN both for left-side deviant tones and infrequent omissions of the last tone, while they have MMN for infrequent right-side deviant tones. In the same condition, neglect patients show no P3 response to â€œGlobalâ€• prediction errors for deviant tones, including those in the non-neglected right-side, and omissions. In contrast, when right-side deviant tones are predominant in the acoustic environment, neglect patients have pre-attentive MMN both for right-side deviant tones and infrequent omissions, while they display no MMN for infrequent left-side deviant tones. Most importantly, in the same condition, neglect patients show enhanced P3 response to infrequent left-side deviant tones, notwithstanding that these tones evoked no pre-attentive MMN. Discussion: These findings indicate that â€œGlobalâ€• predictions are independent of â€œLocalâ€• error signals provided by the MMN. These results qualify deficits of predictive coding in the spatial neglect syndrome and show that neglect patients base their predictive behaviour only on statistical regularities related to the frequent occurrence of sensory events on the right side of space. Conclusions: The present study sheds new light on the poorly explored deficits of predictive coding behaviour in patients with left spatial neglect. The high time-resolution of ERPs allowed us to disclose both the pre-attentive and the attentive/belief updating components of these deficits. References: Lasaponara, S., D'Onofrio, M., Pinto, M., Dragone, A., Menicagli, D., Bueti, D., ... & Doricchi, F. (2018). EEG correlates of preparatory orienting, contextual updating, and inhibition of sensory processing in left spatial neglect. Journal of Neuroscience, 38(15), 3792-3808. Lasaponara, S., Fortunato, G., Conversi, D., Pellegrino, M., Pinto, M.,

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Computerized modeling in food selectivity linked to smell, taste, temperature and consistency in people with autism spectrum disorder: a pilot study on video-modeling

Antonio Leo, L. Forchione, V. Ciccarese, S. Invitto

Abstract

The literature highlights how, in the autism spectrum disorder (ASD), in the developmental age, food selectivity (FS) is present, among the various comorbidities. FS or â€œpicky eatingâ€• is often observed in children and could be a frequent cause for parental concern. The present study aimed to analyze a conditioning model through behavioral modeling in ASD with FS (5 children; mean age 7 y.) and in healthy children with FS (5 children; mean age 7 y.). After the anamnestic meeting, the following were assessed: food skills; the chronological history of dietary difficulties; an objective examination of the orofacial structures; observation at the meal to frame directly and concretely how the child eats, the relational dynamics with the caregivers at the time of the meal; the adequacy of functional sensory-motor structures; the posture adopted by the child and caregivers during feeding; the appropriateness of the feeding aids used; the timing of the meal and the behavior of the child. In addition, the sensory parameters (consistency, smell, taste, temperature), behavioral rigidity, and the possible presence of gastrointestinal symptoms were evaluated with relative intensity and frequency. Based on the data obtained, training was carried out taking into account various aspects: a first preliminary phase based on sensory aspects (desensitization) and a second phase aimed at food selectivity aimed at favoring acceptance, increasing the food repertoire, and developing oral motor skills. A 3-month follow-up was subsequently carried out. After having carried out the desensitization training for the reduction of food selectivity linked to the aforementioned aspects (consistency, smell, taste, temperature, etc.). Subsequently, we proceeded with the video-modeling treatment. The experiment lasted 3 months, at the end of which the data of the two groups were collected again to evaluate the significant variations. Children with ASD showed marked improvements in dysfunctional behaviors. Furthermore, in the control group, there was a good reduction in the level of family stress.

Avatar's ethnicity and gender modulate behavioral and physiological reactions to vicarious touch in immersive virtual reality

Matteo P. Lisi, M. Fusaro

Abstract

The subjective experience of being touched can be drastically affected not only by bottom-up variables (e.g. stimulus intensity) but also by top-down variables (e.g. toucherâ€™s social characteristics1). Nevertheless, the neuroscientific investigation regarding the role of these higher-order factors is limited by ethical and practical constraints. Using Immersive Virtual Reality (IVR) we explored the subjective and physiological reactivity of healthy participants who wore a virtual body and observed an avatar caressing different part of it showing that it was possible to induce vicarious feelings of touch2. Here we expand previous knowledge by investigating the possible influence of gender and ethnicity of the touching avatar in modulating the experience of vicarious touch. We used IVR to substitute the participantsâ€™ real body with a virtual one. We collected behavioral (ratings about touch appropriateness, pleasantness, disgust, erogeneity) and physiological (skin conductance responses, heart rate) responses while Caucasian heterosexual men observed touches delivered on different parts of their virtual body by male or female Caucasian and African avatars. Bayesian parameter estimation showed that touches delivered by the female avatar were rated as more appropriate, pleasant and erogenous, and less disgusting compared to the male ones. These effects

were further modulated by the touching avatarâ€™s ethnicity: touches delivered on intimate areas were judged as more appropriate and more erogenous when performed by the female ingroup compared to the female outgroup avatar, and they were rated as less disgusting when delivered by the ingroup male compared to the outgroup male avatar. At the physiological level, the outgroup male touches elicited higher reactivity compared to the ingroup male touches, in particular when delivered on the intimate and social areas. No effect on the heart rate signals was found. Taken together, our results confirm that heterosexual men tend to avoid same-gender touch2; this effect seems to be enhanced by the toucherâ€™s outgroup membership, suggesting a multi-layered stigmatization process. Future neuroimaging studies could shed light on the role of cognitive, affective and somatosensory components in shaping the outgroup and same-gender touch avoidance. Moreover, under the intergroup contact hypothesis, future studies could investigate whether positive virtual tactile interactions with outgroup avatars could reduce negative attitudes toward them, so that virtual touch may act as an important precursor to real intergroup touch. References: Seger, C. R., Smith, E. R., Percy, E. J., & Conrey, F. R. (2014). Reach out and reduce prejudice: The impact of interpersonal touch on intergroup liking. Basic and Applied Social Psychology, 36(1), 51-58. Fusaro, M., Lisi, M. P., Tieri, G., & Aglioti, S. M. (2021). Heterosexual, gay, and lesbian peopleâ€™s reactivity to virtual caresses on their embodied avatarsâ€™ taboo zones. Scientific reports, 11(1), 1-12.

γtACS boosts iTBS effects on natural frequency oscillations in dorsolateral prefrontal cortex

Michele Maiella, E. Casula, I. Borghi, A. Assogna, M. Pellicciari, A. D'Acunto, G. Koch

Abstract

Gamma frequency band seems to have a fundamental role in synaptic plasticity dynamics. Consequently, developing methods to modulate and potentiate oscillations could be significant for translational research. Indeed, the aim of the study was to develop a powerful tool able to induce long-lasting plastic changes by the combination of two non-invasive brain stimulation techniques over the left dorsolateral prefrontal cortex (lDLPFC): the intermittent theta burst stimulation (iTBS) and transcranial alternating current stimulation (tACS). To reach this purpose we enrolled 15 healthy participants which underwent three experimental stimulation conditions aimed to understand the neurophysiological effects of iTBS-tACS combination and the specific role of the frequency induced by the tACS (Î³, gamma; Î¸, theta): (1) iTBS + Î³tACS (2) iTBS + Î¸tACS (3) iTBS + sham tACS. To assess long lasting effects of the stimulation on cortical oscillations we used electroencephalography (EEG) combined with transcranial magnetic stimulation (TMS) on left/right DLPFC and vertex in three time points: T0 (baseline), T1 (right after stimulation) and T2 (20 minutes after stimulation). We analyzed natural frequency expression (the most expressed frequency, 25 Hz in lDLPFC) in terms of oscillation frequency power and shifting in the different time points. Frequency power analysis showed an opposite effect of the stimulation conditions in lDLPFC: iTBS + Î³tACS increased the power between T0 vs T2, while iTBS + Î¸tACS decrease it both in T0 vs T1 and T0 vs T2. No effects were prompted by the iTBS + sham tACS condition. The analysis of the natural frequency shifting in time of lDLPFC revealed a modulation in the iTBS + Î³tACS condition between T0 vs T1. iTBS + Î¸tACS /sham tACS conditions had no effects on natural frequency shifting. These results can be explained by the iTBS ability to alter cortical inhibition and GABA-ergic synaptic transmission, which result in an enhancement of Î³ band expression (Benali et al. 2011). Thus, the combination with Î³tACS, able to entrain Î³ frequency, induced a boosting of the long-lasting effect of the iTBS on the oscillatory activity. In conclusion, iTBS + Î³tACS stimulation was able to induce long-lasting changes in cortical oscillations in terms of natural frequency for what concern power and shifting in lDLPFC. This property could be useful for clinical application for psychiatric and neurological diseases. References: Benali A, Trippe J, Weiler E, Mix A, Petrasch-Parwez E, Girzalsky W, Eysel UT, Erdmann R, Funke K. Theta-burst transcranial magnetic stimulation alters cortical inhibition. Journal of Neuroscience. 2011 Jan 26;31(4):1193-203.

Emotion recognition in faces wearing surgical mask

Natale Vincenzo Maiorana, M. Dini, M. Guidetti, M. Reitano, C. Paride, A. Priori, R. Ferrucci

Abstract

Objective: The aim of the study was to assess the effect of surgical masks on emotion recognition and to clarify the role of upper and lower face regions in emotion recognition. Material: 31 subjects (16 Male; aged 21-58), were enrolled. Stimulus faces consisted of 8 Caucasian adults portrait photos (four men, four women) extracted from the NimStim Face Stimulus Set expressing anger, happiness, sadness, and neutral expression. Four alternative sets of pictures were generated: no masked (NM) consisting in a fully visible face. Masked face (MF) in which a surgical mask was superimposed to the stimulus face. Mouth only (MO) consisting in a cropped version of the stimulus to make only the lower part of the face visible. Eyes only (EO) consisting in a cropped version of the stimulus to make only the upper part of the face visible. Methods: Subjects had to respond by pressing a key to discriminate between neutral, sad, happy, or angry faces in a computer based Facial Emotion Recognition Task. Stimuli were presented in 4 different conditions (NM, MF, MO, EO) divided in 4 blocks counterbalanced between participants. Each block was composed by 96 randomized trials. Results: Error rates analysis showed main effects of condition F (3,90) = 54,346 p = 0,000 Î·2 = 0,644 and face emotion F (3,90) = 64,404 p =0,000 Î·2 = 0,682, and interaction between condition and face emotion F (9,270) = 7,936 p = 0,000 Î·2 = 0,209. Post hoc t-tests with Bonferroni p-value correction (p = 0.012) showed that subjects made more error in MF than in NM condition judging sad faces [(Mean Â± S.D.) NM vs MF: 11.15 Â± 8.22 vs 26.47 Â± 12.57 p < 0.012]; angry faces [(Mean Â± S.D.) NM vs MF: 3.36 Â± 4.86 vs 18.81 Â± 8.32 p < 0.012]; neutral faces [(Mean Â± S.D.) NM vs MF: 3.22 Â± 4.39 vs 7.93 Â± 7.16 p < 0.012]. Happiness recognition was not affected by surgical mask [(Mean Â± S.D.) NM vs MF: 2.82 Â± 3.93 vs 5.10 Â± 4.65 p > 0.012]. Discussion: Recognition of happiness is not affected by the perceptual occlusion due to the surgical mask. For other emotions, surgical mask significantly worsens emotion recognition. Conclusions: It is possible that the upper face region is more informative in happiness than in neutral, anger or sadness recognition.

Loss of speech and functional impairment in Alzheimer's disease-related primary progressive aphasia: predictive factors of decline

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Abstract

OBJECTIVES: Alzheimerâ€™s disease (AD)-related primary progressive aphasia (PPA) includes patients with established Alzheimerâ€™s pathology and linguistic features extending from logogenic PPA to mixed-PPA with impairment in naming, repetition and agrammatism. Patients in this group showed different trajectories of linguistic deficits and nonverbal features. We aimed to identify features associated with different disease courses. METHODS: 58 consecutive patients referred to our center for language disorders were enrolled. All patients underwent neuropsychological evaluation, 18F-Fluorodeoxyglucose-PET brain scan, CSF biomarkers measurement and APOE genotype analysis at baseline and underwent neurological follow-up for a mean time of 2.94 (3.97) years. For the present work, we considered patients diagnosed with AD-related PPA. Outcome variables were progression to total loss of speech (TLoS) ability and loss of functional autonomy (LoFA) in daily life. RESULTS: 23 patients were included. At follow-up, 11 patients progressed to TLoS (TLoS+). TLoS+ patients had greater impairment in writing (0.00 [1.00] vs. 1.00 [0.00], p=0.032, Î·2=0.27) and higher median t-tau concentration (531.00 [560.00] vs. 1069.00 [423.00], p=0.049, Î·2=0.21) as compared to TLoSâ€“ patients. A cut-off value of 955 pg/mL was found to discriminate TLoS+ and TLoSâ€“ patients with an accuracy of 76.19% (95% C.I.=59.15-93.23). TLoS+ patients had hypometabolism in middle and superior temporal gyrus, precuneus and paracentral lobule. Eleven patients who progressed to LoFA had greater impairment in single-word comprehension as compared to patients who maintained autonomy in self-care (0.50 [0.50] vs. 0.00 [0.50], p=0.001, Î·2=0.49). CONCLUSIONS:

Predicting the clinical course of PPA is a challenging issue. Furthermore, speech degradation and impairment in self-care may progress independently and in a very wide range of time. Few studies explored predictive indexes of progression in PPA patients and only two studies included CSF biomarkers. Through a multidimensional approach, comprising extensive neuropsychological assessment, functional neuroimaging, CSF biomarkers and genetic variantsâ€™ analysis, we found that AD-related PPA patients who will progress to total loss of speech may be detected at baseline according to linguistic profile, CSF t-tau and brain metabolic pattern. Impairment in single-word comprehension may be used to identify patients who will need assistance in self-care over a three-year period. These features could be useful tools for caregivers, to prepare sufficient resources to care the patients. Moreover, as a treatment directed at the underlying AD pathology has been recently approved, the predictive factors we identified might be considered to select patients to be eligible for disease modifying therapies and future clinical trials on AD. References: Mazzeo S, Polito C, Padiglioni S, Berti V, Bagnoli S, Lombardi G, Piaceri I, Carraro M, De Cristofaro MT, Passeri A, Ferrari C, Nacmias B, Sorbi S, Bessi V. Linguistic profiles, brain metabolic patterns and rates of amyloid-Î² biomarker positivity in patients with mixed primary progressive aphasia. Neurobiol Aging. 2020 Dec;96:155-164. Sebastian R, Thompson CB, Wang NY, Wright A, Meyer A, Friedman RB, Hillis AE, Tippett DC. Patterns of Decline in Naming and Semantic Knowledge in Primary Progressive Aphasia. Aphasiology. 2018;32(9):1010-1030. doi: 10.1080/02687038.2018.1490388. Epub 2018 Jun 28. PMID: 30613121; PMCID: PMC6317736. Ferrari C, Polito C, Vannucchi S, Piaceri I, Bagnoli S, Lombardi G, Lucidi G, Berti V, Nacmias B, Sorbi S. Primary Progressive Aphasia: Natural History in an Italian Cohort. Alzheimer Dis Assoc Disord. 2019 Jan-Mar;33(1):42-46. doi: 10.1097/WAD.0000000000000282. PMID: 30640256.

Effect of individualized vs group-level target selection on reliability of network-targeted TMS

Arianna Menardi, R. Ozdemir, D. Momi, E. Tadayon, P. Boucher, A. Vallesi, A. Pascual-Leone, M. Shafi, E. Santarnecchi

Abstract

Aims: Transcranial Magnetic Stimulation (TMS) is a widely-used technique for the noninvasive manipulation of the neurobiological mechanisms underpinning cognition. Although extensively used for research and clinical purposes, recent studies have questioned the reliability of TMS findings. To address this concern, we tested if personalization of the stimulation targets might result in greater induced activity and more reliable response patterns. Materials: Twenty-four healthy young individuals participated to two sessions, one month apart, of a single pulse TMS protocol during concomitant electroencephalography (EEG) recording. During both sessions, two nodes belonging to the Dorsal Attention (DAN) and Default Mode (DMN) Networks respectively were stimulated. In the group-level condition, the stimulation targets were identified based on group-derived networksâ€™ maps; whereas in the individualized condition, stimulation sites were personalized based on an iterative seed-based approach run on the individual resting state functional magnetic resonance imaging data. Methods: TMS-EEG analyses were explored at the local and network level in terms of the induced changes, in respect to baseline, i) in the six electrodes closer to the stimulation hotspots and ii) at the source level for the DAN and DMN respectively. To test for differences in the induced activity between targeting scenarios, within-subjects repeated measures ANOVAs were run. To control for the reliability of the evoked response, intra-class correlation analyses were run comparing the similarity in the evoked response across sessions. Results: No differences were observed in the amount of induced activity between the group-level and individualized targeting of the DAN at neither the local nor network level. On the other hand, a higher induced activity was observed following the individualized targeting of the DMN at the local level. Significant reliable patterns were observed following the individualized targeting of the DAN at both the local and network level, and at only the network level for the DMN. Discussion: Preliminary findings suggest that the personalization of stimulation targets in TMS single pulse protocols might result in enhanced reliability of the evoked response in a network-dependent fashion. Indeed, individualized stimulation yielded significant reliable patterns more in the DAN, than in the DMN, stimulation condition. Recent evidence has proven the DAN to be one of the networks showing the

highest inter-subject difference in its topology1, which might explain why its targeting benefits most from individualized approaches. Conclusions: Knowledge of the individual resting state topography can be useful to tailor stimulation protocols and possibly improve their reliability. References: 1- Gordon, E. M. et al. Precision Functional Mapping of Individual Human Brains. Neuron, 2017, 95, 791-807.

Local and distributed fMRI changes induced by 40Hz gamma tACS of the bilateral dorsolateral prefrontal cortex

Lucia Mencarelli, L. Monti, S. Romanella, F. Neri, G. Koch, S. Ricardo, G. Ruffini, G. Sprugnoli, S. Rossi, E. Santarnecchi

Abstract

Objective: Over the past years the possibility of modulating fast brain oscillatory activity in the gamma (Î³) band through transcranial alternating current stimulation (tACS) has been discussed in the context of both cognitive enhancement and therapeutic scenarios. However, the effect of tACS outside the motor cortex is still unclear, as well as its spatial specificity. Here we present a concurrent tACS-fMRI study to characterize the impact of 40Hz-tACS applied over bilateral dorsolateral prefrontal cortex (DLPFC) using a block design in healthy subjects. Considering the DLPFC as the main cortical targets in NIBS studies aimed at cognitive enhancement or clinical applications, we decided to stimulate this area, looking at the accuracy of 40Hz-tACS in target engagement, thus considering both on-target and off-target effects. Data would allow us to test whether the hypothesized 40Hz-tACS induced BOLD modulations are observable only at the stimulation site as predicted by biophysical modeling (on-target effects), as well as show any off-target effects relevant for planning of future tACS interventions in clinical and non-clinical populations. Material AND METHODS: Fifteen subjects underwent a concurrent tACS-MRI protocol via an MRI-compatible stimulation system installed inside the MRI scanner. Two fMRI runs were completed concurrently to tACS using a block design fMRI paradigm, alternating 60 seconds of 40-Hz tACS over the DLPFC and 60 seconds of no-stimulation. RISULTS: Results suggest an increase in Blood Oxygenation Level Dependent (BOLD) activity in the bilateral DLPFC as the primary stimulation target, as well as in surrounding brain areas affected by stimulation according to biophysical modeling, i.e., the premotor cortex and anterior cingulate cortex (ACC). However, off-target effects were also observed, primarily involving the visual cortices, arguably as a result of phosphene perception, with further effects on the supplementary motor areas (SMA), left subgenual cingulate and right superior temporal gyrus. The network mapping performed revealed that the functional connectivity profile of the resulting areas resembles Anterior Salience and Dorsal Attention Networks. DISCUSSION: The specificity of 40Hz-tACS over bilateral DLPFC and the possibility for network effects should be considered especially in the context of recently promoted gamma-induction therapeutic protocols in neurodegenerative disorders. CONCLUSIONE: Even if preliminary, our results expand the evidence on online effects of 40Hz-tACS applied during resting-state on bilateral DLPFC, providing relevant details on modeling-based target engagement and network-level effects. Findings might help the design of future interventions in both healthy individuals and psychiatric and neurological disorders characterized by a dysregulation of gamma activity.

Detection of spontaneous and posed dynamic emotional facial expressions using Time Frequency Analysis

Alessio Miolla, G. Melis, A. Maffei, C. Scarpazza

Abstract

OBJECTIVES: Do healthy individuals process differently genuine and posed emotional facial expressions? If so, is it possible to find specific neural correlates of genuineness in the processing of genuine and posed emotions? The current contribution aims to respond to the following questions, exploring how individuals perceive and react to genuine and not genuine emotions. MATERIALS: Stimulus materials were taken from the PEDFE set, which contains both genuine and posed emotional facial expressions. Overall, eighteen

dynamic stimuli (i.e., nine genuine and nine posed) of Fear, Happiness, and Disgust were selected from the dataset for a total block of 54 stimuli. The block of stimuli was presented three times, resulting in a total sequence of 162 stimuli. METHODS: The cortical activity of 33 participants was recorded during their perception of three different facial expressions of genuine and posed happiness, fear, and disgust. Data were collected continuously from 62 Ag/AgCl electrodes placed on an elastic cap according to the 10-20 system, using a Micromed SD MRI 64 system. RESULTS: Overall, we observed great differences in both the timing and the topography of the canonical EEG bands. In particular, compared to genuine happiness, posed happiness revealed increased delta and theta power at the onset and offset of the facial expressions over frontal sites. Compared to posed fear, genuine fear elicits an increase in alpha and beta bands followed by an increase in theta activity. Finally, for facial expressions of disgust, we found an early increased theta, alpha, and beta activity for the posed expressions, followed by increased activity in alpha and beta bands during the perception of genuine disgust. DISCUSSION: The boosted activation of posed happiness may be explained by the more cognitive load processes involved during the onset and after the apex of the expression, two deceptive temporal clues when the difference between genuine and posed happiness is more evident. Regarding fear and disgust, the endogenous valence of the genuine emotional expressions may have yielded a greater impact of authentic emotional expressions on participants' arousal and perception.
CONCLUSIONS: This study adds to the literature on emotion genuineness perception a new important step forward by highlighting that spontaneous and posed emotions are processed differently in our brain, as revealed by EEG time-frequency analysis. These results suggest that the knowledge we have so far on the perception of emotions conveyed by faces could potentially be partial and biased by the (un)conscious perception of the non-genuineness of perceived emotions. References: Krumhuber, E. G., Kappas, A., & Manstead, A. S. R. (2013). Effects of dynamic aspects of facial expressions: A review. Emotion Review, 5(1), 41â€“46. https://doi.org/10.1177/1754073912451349 Maffei, A., & Sessa, P. (2021). Eventâ€•related network changes unfold the dynamics of cortical integration during face processing. Psychophysiology, 58(5).
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Gut markers of bodily self-consciousness

Alessandro Monti, G. Porciello, M. S. Panasiti, S. M. Aglioti

Abstract

Objectives: bodily self-consciousness, the state of mind that allows humans to be aware of their own body, forms the backdrop for almost every human experience, yet its underpinnings remain elusive. In particular, while the contribution of sight, touch, heartbeats and breathing to corporeal awareness is now ascertained, the role of deep, sub-diaphragmatic signals is unknown, as organs in the abdominal cavity are difficult to reach without relying on invasive methods. In the present study we used for the first time a minimally invasive ingestible to probe the contribution of the stomach and the intestine to bodily self-consciousness. Materials and Methods: thirty-one healthy male participants (age: 20-30 years) took part in the study. Surface electrogastrography and an ingestible capsule fitted with biosensors allowed us to probe if gut physiology correlates with bodily self-consciousness during the Embreathment illusion (1). Results: we found that specific patterns of stomach and large intestine activity (temperature, pressure, pH, and gastric peak frequency) covary with specific facets of bodily self-consciousness (feelings of body ownership, agency, location, and disembodiment). Furthermore, we showed that the link between gastro-intestinal parameters and bodily self-consciousness is often moderated by individual levels of interoception. Discussion and conclusions: according to our results, each class of gut signals, particularly of those recorded in the stomach, exerts a quite specific role within the framework of bodily self-consciousness: stomach temperature is a marker of perceived ownership and stomach pressure has a special relationship with agency, while pH is tied to the senses of location and ownership. In parallel, when any of these three signals

goes up, participants feel less disembodied, particularly when their virtual body does not match their real body. These results reveal a deep visceral pathway to the self-conscious perception of ourselves as embodied beings.
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rTMS-induced long-lasting language improvements associated with resting state functional connectivity changes in Primary Progressive Aphasia

Francesco Neri, S. Romanella, M. Tomai Pitinca, S. Taddei, L. Monti, S. Benocci, E. Santarnecchi, S. Cappa, A. Cinti, C. Smeralda, A. Benelli, S. Rossi

Abstract

Introduction: Primary Progressive Aphasia (PPA) is a clinical neurodegenerative syndrome characterized by language impairment (i.e., aphasia). There are three main PPA syndromes: the non-fluent/agrammatic variant (nfvPPA) is characterized by grammatical impairments; the semantic form (svPPA), with worsening difficulties to understand words meaning; the logopenic form (lvPPA), that is characterized by intermittent word-finding hesitation, working memory deficits and anomia. Many patients do not fit perfectly into one of these three syndromes and other subtypes have been proposed: the mixed subtype (mvPPA), where impaired grammatical structure and words meaning deficits are observed, or the anomic subtype (avPPA), where all deficits of lvPPA are detectable, excepted for repetition of words and sentences impairment. To date, the only available treatment is speech and language therapy (SLT). Methods: Four male (1 avPPA; 2 lv-PPA and 1 nfvPPA) patients underwent 10 consecutive daily sessions of repetitive Transcranial Magnetic Stimulation (rTMS), that was real-time guided with a neuro-navigation system, targeting the patientsâ€™ left Brocaâ€™s area. Immediately after each rTMS session, patients underwent one-hour SLT, capitalizing the rTMS neuromodulatory after-effect. Before (T0), immediately after (T1), and one month (T2) after the rTMS intervention, language performance was tested with an extensive neuropsychological assessment and resting-state functional connectivity (rsFC) was measured with functional magnetic resonance imaging (fMRI). Results: At the end of the rTMS procedure, linguistic abilities were long-lasting enhanced in all patients. Moreover, we found a modification of the rsFC pattern between the pars opercularis of the left cerebral hemisphere and the Crus II of the right cerebellum in the two lvPPA patients and other rsFC modification of language brain network in avPPA and nfvPPA patients. Conclusions: rTMS over Brocaâ€™s area combined with SLT led to significant and relatively persistent improvement in linguistic abilities associated to rsFC changes.

rTMS for the treatment of hearing loss in patients with wearable hearing aids

Francesco Neri, C. Cappello, L. Burzi, S. Romanella, A. Benelli, A. Cinti, S. Rossi, M. Mandalà

Abstract

Introduction: acquired hearing loss (HL) is the partial or total inability to perceive sounds that should occur in one or both ears. Permanent HL is mostly caused by presbycusis or aging, also accompanied by functional and anatomical changes of ear-brain pathways, that govern auditory information processing [1]. Wearable hearing devices compensates the deafness, but sensory deficits are still reported in many cases, that can lead to a decrease of daily life activities. Repetitive Transcranial Magnetic Stimulation (rTMS) is a non-invasive brain stimulation technique used to promote cortical networks plasticity. On these basis, rTMS could be a valid aid and an innovative approach for patients with HL for a recovery of auditory perception and linguistic abilities [2]. Methods: we recruited 19 right-handed HL participants (5 females; mean age: 60.33Â±20.61) wearing removable hearing aids. Participants were randomly assigned to an active (3 females; mean age: 59.60Â±23.87) or a sham (2 females; mean age: 61.80Â±14.20) group. Active or sham 10 Hz-rTMS was delivered over participantsâ€™ left primary/associative auditory cortex (between

Brodmann 42/22) for 5 consecutive days. Before, immediately after and one week after the end of the treatment (T0,T1,T2), a hearing test and a matrix sentence test were administered. Repeated_measures_ANOVA analysis was run [Factors: Time (3 levels: T0,T1,T2); Group (2 levels: Active,Sham)] to verify changes of the hearing threshold (HT) and of the sentence comprehension ability (SCA). Results: we found a significant HT reduction in both groups (main effect of Time; p<.05; T1,T2 from T0), with no interaction between Time and Group. Moreover, we found an higher SCA in both groups (main effect of Time; p<.05; T1,T2 from T0) and a trend toward a significance of an higher SCA performance in the Active group at T2 from T0 (p>.05). Discussion: both sham and active rTMS improve the HT in deaf patients. Furthermore, the trend towards a better SCA performance in the active group, suggests that the real rTMS might favor brain neuromodulatory changes pivotal to percept complex sentences. Conclusions: rTMS might have an effect on peripheral-cortical pathways interactions and improve the clinical condition of HL patients. References:

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Small world architecture and memory performance in cognitive decline: an eeg study

Chiara Pappalettera, F. Miraglia, D. Quaranta, C. Marra, P. Rossini, F. Vecchio

Abstract

Aim: Determine whether brain connectivity of resting-state networks correlate with memory in patients affected by Alzheimerâ€™s disease (AD) and in subjects with mild cognitive impairment (MCI). Methods: One hundred and forty-four subjects were recruited: 70 AD (MMSE Mini Mental State Evaluation 21.4), 50 MCI (MMSE 25.2) and 24 healthy subjects (MMSE 29.8). Undirected and weighted cortical brain network was built to evaluate graph core measures to obtain Small World parameters. eLORETA lagged linear connectivity as extracted by electroencephalogram (EEG) signals was used to weight the network. Results: A high statistical correlation between Small World and memory performance was found. Namely, higher Small World characteristic in EEG gamma frequency band during the resting state, better performance in short term memory as evaluated by the digit span tests. Discussion: AD brain topology can be represented by a progressive derangement of the brain organization in hub regions and long-range connections to spoke nodes causing Small-World architecture alteration. In fact, decreasing local and global connectivity parameters, the large-scale functional brain network organization in AD deviates from the optimal Small-World architecture toward a more â€˜â€˜orderedâ€• type (as reflected by lower values of SW) leading to a less efficient information exchange between brain areas in line with the disconnection hypothesis of AD (Vecchio et al., 2014). These results are reflected on the EEG by the observation that a less ordered brain network (as reflected by increasing value of SW) in gamma band is associated to better memory performance. Several studies demonstrated that gamma-band activity is strongly associated with behavioral performance (reaction time and accuracy) in several memory tasks, including episodic, encoding, retrieval (Kaiser et al., 2008). Furthermore, a higher gamma-band activity was demonstrated in participants with an elevated recognition memory performance (Busch et al., 2008). Conclusion: Such Small World pattern might represent a biomarker of working memory impairment in older people both in physiological and pathological conditions. In particular, understanding the role of EEG gamma oscillations in the network dynamics involved in memory performance is not only important for understanding memory in cognitive decline patients, but can also serve as a model for understanding large-scale brain network dynamics and their relation to other cognitive phenomena. References: Busch NA, Groh-Bordin C, Zimmer HD, Herrmann CS. Modes of memory: early electrophysiological markers of repetition suppression and recognition enhancement predict behavioral performance. Psychophysiology. 2008;45(1):25-35. Kaiser J, Heidegger T, Lutzenberger W. Behavioral relevance of gamma-band activity for short-term memory-based

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Waving together single pulse intracranial electrical stimulation with concurrent stereo EEG and scalp hd-EEG recording

Sara Parmigiani, S. Russo, E. Mikulan, F. Zauli, A. Rubino, A. Cattani, M. Fecchio, J. Favaro, I. Sartori, P. d'Orio, J. Lanzone, M. Massimini, A. Pigorini

Abstract

Single pulse direct electrical stimulation (SPES) is an established technique in the investigation of the seizure spread patterns for drug-resistant epilepsy. Besides, it can offer direct evidence on functions localization, and the resulting cortico cortical evoked potentials (CCEPs) can be used to estimate the effective connectivity in many cortical areas. However, due to the sparse sampling of the stereotactically implanted electrodes (SEEG), the precise impact of this stimulation over the brain structures and functions was not fully considered and clearly described. The aim of the present study was to assess whether and to what extent the physical properties of the SPES delivered through SEEG affects the concurrent high-density scalp EEG signal. This combination is a brand-new procedure that can be carried out during the evaluation of epileptic patients undergoing surgery. Thanks to the hd-EEG, it is possible (i) overcoming the sparse-sampling limitations, (ii) widening the single-study research focuses, and eventually (iii) improving the between subjects' comparisons for clinical and research purposes. Moreover, this comprehension could be useful also for mirroring non-invasive stimulation results (Rosanova et al., 2009). 37 epileptic patients were enrolled in the study. For each patient, stereotactically implanted electrodes covered various brain regions. Concurrent scalp recordings were gained with a hd-EEG. SPES consisted in biphasic positive-negative currents. The following stimulation parameters were analyzed, both as single parameters and in combination: intensity (<2mA, 3 mA and 5mA), frequency (0.5Hz â€“ 1Hz), duration (0.3ms, 0.5ms, 1ms), geometry (scalp distance, white matter distance, angle), and region (frontal, temporal, occipital). Overall, 450 sessions were recorded. Impact of features on the CCEPs shown that: The amplitude of the N1 component measured as in (Matsumoto et al. 2004; Trebaul et al. 2018) revealed difference for intensity: 5mA>3mA and angle: perpendicular>parallel. GMFP was affected by stimulus duration: 1ms>0.5ms. White matter distance AND angle affected both N1 and N2 amplitude and latency, being the WM_perpendicular the more impacting combination. Finally, the main frequency of oscillations was found to reflect on the site of stimulation, with some different tendency between the occipital frequencies (up to 10Hz), parietal (~15Hz), and more rapid oscillations in frontal areas (up to 25Hz). All $p<0.05$. Therefore, an effective combination of invasive deep-structures stimulation with non-invasive whole-brain cortical recording in human needs a full-blown comprehension of the underling electrophysiological dynamics. Here, we provided a key step in this direction by systematically investigating the main stimulation parameters and contacts localizations in a rich dataset. References: Rosanova, M., Casali, A., Bellina, V., Resta, F., Mariotti, M., & Massimini, M. (2009). Natural frequencies of human corticothalamic circuits. Journal of Neuroscience, 29(24), 7679-7685. Matsumoto, R., Nair, D. R., LaPresto, E., Najm, I., Bingaman, W., Shibasaki, H., & LÃ¼ders, H. O. (2004). Functional connectivity in the human language system: a cortico-cortical evoked potential study. Brain, 127(10), 2316-2330. Trebaul, L., Deman, P., Tuyisenge, V., Jedynak, M., Hugues, E., Rudrauf, D., ... & David, O. (2018). Probabilistic functional tractography of the human cortex revisited. NeuroImage, 181, 414-429.

Functional shifting of cortical oscillatory dynamics in the motor recovery after stroke: a TMS-EEG study

Maria Concetta Pellicciari, S. Bonnì, M. Maiella, L. Mencarelli, E. Casula, C. Caltagirone, G. Koch

Abstract

Objectives: In the first months after stroke, the brain undergoes a complex reorganization to allow compensatory mechanisms that promote functional recovery, providing a potential time window of opportunity for neuroplasticity changes. The aim of this study was to track spontaneous motor cortical reorganization in sub-acute stroke patients until two months after the ischemic event and to identify the neurophysiological markers associated to clinical and behavioral recovery. In order to assess motor cortical reorganization after stroke, a TMS-EEG approach was adopted to investigate the functional changes in cortical excitability and oscillatory activity. Materials: Twenty-three patients in the sub-acute phase of ischemic stroke with motor symptoms were evaluated within 20 days and after 60 days after stroke onset. Methods: For each time-point, EEG cortical activity evoked by single TMS pulses was assessed over the motor cortex of the affected and unaffected hemisphere. We evaluated global TMS-evoked activity and TMS-evoked oscillations in different frequency bands. These measurements were paralleled with clinical and behavioral assessment. Repeated measures ANOVA and Friedman test were used to evaluate changes over time of all measures. Results: We observed a spontaneous shifting in cortical oscillations in specific frequency bands, as assessed from the motor cortex of affected hemisphere. Specifically, stroke patients showed a significant increase in TMS-evoked alpha oscillations after 60 days following stroke onset, as compared with oscillatory activity assessed within 20 days after stroke. The cortical changes were paralleled with the clinical and behavioural amelioration, allowing us to hypothesize a critical role of alpha oscillatory activity in motor recovery. Discussion: The time course of acute stroke-induced changes in motor cortical excitability and oscillatory activity during spontaneous recovery were investigated, combining a TMS-EEG approach with clinical and behavioural assessments. Our findings show that the spontaneous recovery following stroke is characterised from the neurophysiological point of view by oscillatory activity shifting in alpha-frequency bands in the affected hemisphere. Conclusion: For the first time, in this study we have observed a functional reorganization of cortical oscillatory dynamics underlies motor recovery after stroke. These results provide new insight into how and when neuromodulatory interventions could drive neuroplasticity in a functional direction, paving the way to a more focused definition about potential therapeutic applications of rhythmic brain stimulation with rehabilitative aims.

Knocking at the brain's door: a direct measure of brain excitability in Alternating Hemiplegia of Childhood

Marco Perulli, D. Jimenez-Jimenez, S. D'Ambrosio, K. Silvennoinen, S. Zagaglia, S. Sisodiya, S. Balestrini

Abstract

Objectives: Alternating hemiplegia of childhood (AHC) is a rare neurodevelopmental syndrome caused by a mutation in ATP1A3, encoding a Na/K-ATPase pump critical to restore membrane excitability, particularly in fast-spiking interneurons (1). Both paroxysmal and static clinical features of AHC are typically distributed asymmetrically (2). Transcranial Magnetic Stimulation (TMS) combined with electromyography (EMG) indirectly shows fluctuations in cortical excitability in AHC, with MEP decreasing during a hemiplegic episode (3). Our aim was to obtain a direct, bilateral and longitudinal measure of excitability, using hd-EEG as a readout of TMS response (TMS-EEG). Materials and Methods: five AHC adults and five healthy controls (HC) were tested with TMS-EEG on two separate sessions. Primary motor cortex was targeted using neuronavigation and stimulated bilaterally at subthreshold intensity (98% of resting Motor Threshold). A qualitative analysis of TMS evoked potentials was performed. Pearson correlation test was used to evaluate the interhemispheric symmetry. Differences in interhemispheric symmetry between groups and sessions were calculated using Mann-Whitney test. Results: in one patient we recorded both a baseline condition and a quadriplegic spell, during which the EEG response was abolished in the explored hemisphere. AHC patients exhibited a higher degree of interhemispheric asymmetry compared to HC (rho=0.39+/-0.25 vs. 0.69+/-0.04, p=0.012). A degree of intersession variability was also observed in patients (rho=0.21+/-0.07 vs. 0.58+/-0.29, p=0.052). Discussion and Conclusions: These preliminary data support the central origin of the excitability abnormalities previously described and demonstrate an increased interictal asymmetry in

AHC patients. Studies in larger cohorts are needed to further explore the role of TMS as a biomarker and objective outcome measure in interventional trials. References: Hunanyan AS, Helseth AR, Abdelnour E, et al. Mechanisms of increased hippocampal excitability in the Mashl+/âˆ’ mouse model of Na+/K+-ATPase dysfunction. Epilepsia. 2018;59(7):1455-1468. Mikati MA, Kramer U, Zupanc ML, Shanahan RJ. Alternating hemiplegia of childhood: Clinical manifestations and long- term outcome. Pediatr Neurol. 2000;23(2):134-141. Stern WM, Desikan M, Hoad D, et al. Spontaneously fluctuating motor cortex excitability in alternating hemiplegia of childhood: A transcranial magnetic stimulation study. PLoS One. 2016;11(3):1-18.

Attentional processing of body images in patients with anorexia nervosa: a Contingent Negative Variation study

Alessia Petritis, D. Mannarelli, C. Pauletti, A. Maffucci, N. Locuratolo, I. Taddei, M. Caredda, F. Fattapposta

Abstract

Aim: Anorexia nervosa (AN) is an eating disorder characterized by restrained eating, being significantly underweight, disturbance in self-perception of weight/shape, and intense fear of gaining weight or becoming fat. Previous neuropsychological studies reported cognitive impairment especially in executive functioning such as the inhibitory control, but also in arousal, and in emotional and reward processing. The aim of the present study is to investigate the attentional processing in AN patients using a Contingent Negative Variation study. Materials and Methods: Fourteen healthy subjects underwent a visual S1-S2 motor task during three separate sessions in which S1 was a warning stimulus and S2 an imperative stimulus with a 50-50% double choice reaction time (RT) task. In the first session (CNV1) both S1 and the two S2 stimuli were neutral. In the second session (CNV2), S1 stimulus was neutral, whereas S2 was either neutral (50% of trials) or salient and target (body images). The third session (CNV3) was similar to CNV2 with the exception of S1, which was salient (body images). The three CNV sessions were randomized between subjects. Total-CNV and W2-CNV areas were measured. Performance measures were obtained by calculating mean RTs of correct responses and accuracy (absolute number of errors) for each CNV session. Results: Total-CNV and W2-CNV amplitudes were bordering on significance, with higher amplitudes in CNV2 than in CNV1 and CNV3 sessions (total-CNV: p=0.1; W2-CNV: p=0.08). No difference emerged in performance measures. Discussion: Our data indicate that when the body salient stimulus is preceded by a neutral warning stimulus, even if it determines an enhancement of the alerting state, there is no improvement in the performances. Furthermore, when the body stimulus, besides being a target, is also a warning stimulus, as in our CNV task, this enhancement effect is prevented. These results point to an executive attentional dysfunction probably linked to the emotional bias induced by the processing of a body-related stimulus. In AN in fact, the activation in response to body-related visual stimuli is associated to an abnormal activation of ventral striatum, orbitofrontal cortex, anterior cingulate cortex and insula, crucial regions in the reward system. Conclusion: The viewing of body stimuli is related to a dysfunctional attentive processing in AN patients. References: Simon JJ, Stopyra MA, Friederich HC. Neural Processing of Disorder-Related Stimuli in Patients with Anorexia Nervosa: A Narrative Review of Brain Imaging Studies. J. Clin. Med. 2019; 8: 1047 Wolz I, Fagundo AB, Treasure J, Fernando FernÃ¡ndez-Aranda F. The Processing of Food Stimuli in Abnormal Eating: A Systematic Review of Electrophysiology. Eur. Eat. Disorders Rev. 2015;23: 251â€“261. Macar F, Vidal F. The CNV peak: An index of decision making and temporal memory. Psychophysiology 2003;40:950â€“954.

Non-invasive associative plasticity induction between PMv and M1: a TMS-EEG study

Valentina Pezzopane, D. Spampinato, M. Assogna, G. Koch

Abstract

It is well known that paired associative stimulation (PAS) is capable of inducing forms of cortical plasticity when paired pulses are repeatedly applied over interconnected cortical areas such as the ventral premotor

cortex (PMv) and primary motor cortex (M1). PAS is widely used across many laboratories to modulate behavior or restore aberrant mechanisms of plasticity in diverse patient populations. However, assessing PAS-induced plasticity remains challenging since the aftereffects of stimulation are measured via motor evoked potentials (MEPs) evoked by transcranial magnetic stimulation (TMS), which exhibit large inter and intra-individual variability. Aim: Here, by combining transcranial magnetic stimulation (TMS) with electroencephalography (EEG), we aimed at investigating PAS effects over both areas (PMv, left M1), and on the opposite hemisphere (right M1), as well as the modulation induced on their connectivity in humans. Methods: In the first session, we tested PMv-M1 connectivity by a paired-pulse TMS protocol, to measure each individualâ€™s effective connectivity of these two areas. In a follow-up session, we assessed how PMv-M1 PAS modulates cortical excitability, by comparing TMS-evoked potentials (TEPs, recorded with EEG). We predicted that the aftereffects of PAS are limited to the region targeted by PAS (i.e. left M1). Results: In the first session, we found that all individuals showed effective inhibitory connectivity between PMv and M1, albeit at various degrees. This result suggests that individuals may show a wide range of TEP responses to PMv-M1 PAS, that are characterized by the strength of their connectivity. In the second session, we found that PAS modulates TEPs only when recorded over the left M1, whereas no changes were observed in TEPs recorded from either PMv or right M1. Discussion: These preliminary results are in line with previous studies (Buch et al., 2011; Veniero et al., 2013), demonstrating that TMS-EEG is a feasible technique to capture PAS-induced plasticity changes. Interestingly, the detected changes in TEPs were limited to the targeted area (i.e. left M1), suggesting that the effects are site-specific. While our data demonstrate that PAS increased cortical plasticity, the mechanisms surrounding this increase remain unclear. Therefore, we will carry out a future analysis that will assess whether changes in cortical plasticity are tied to the coherence of particular frequencies between PMv and M1. References: Buch, E. R., Johnen, V. M., Nelissen, N., O'Shea, J., & Rushworth, M. F. (2011). Noninvasive associative plasticity induction in a corticocortical pathway of the human brain. Journal of Neuroscience, 31(48), 17669-17679. Veniero, D., Ponzo, V., Caltagirone, C., & Koch, G. (2013). P 158. Neural correlates of Hebbian and anti-hebbian spike-timing-dependent plasticity in human: A TMSâ€“EEG combined study. Clinical Neurophysiology, 124(10), e139.

Inhibitory control in food-related motor task

Silvia Picazio, V. Bianco, G. Koch

Abstract

Object: Human eating behaviour is normally controlled by homeostatic mechanisms in order to keep body weight constant. However, hedonic mechanisms respond to the sensory input associated with nutritive behaviour, especially visual appearance of food and it is well established that several brain areas are differentially activated in food versus no-food pictures. Here, we used a food-specific Go/NoGo paradigm to explore inhibitory control mechanisms in the context of human eating behaviour. Materials: A group of healthy participants performed a food-related Go/NoGo paradigm. Motor Evoked Potentials (MEP) were obtained by delivering transcranial magnetic stimulation (TMS) during task performance. Methods: A sample of twenty healthy, normal-weight participants (mean age 27) performed a 50% probability visual affective Go/NoGo task involving Food and No-Food images as stimuli. Food stimuli included High-Calorie and Low-Calorie food images. The experimental session consisted of a Food-target block and of a No-Food target block. In order to measure corticospinal excitability during the different task conditions, for some trials (1/3 of the total) single-pulse TMS was delivered over the right primary motor cortex (M1) 300ms following stimulus presentation, for some trials (1/3 of the total) single-pulse TMS was delivered over the M1 300ms following the fixation-point presentation, while for remaining trials (1/3 of the total) TMS was not applied. Results: RTs of High-Calorie images were the fastest among conditions and RTs of Low-Calorie images were faster than No-Food images RTs. A specific increase of High-Calorie RTs emerged for TMS condition compared to No-TMS condition. Accuracy was mainly higher for High-Calorie pictures and lower in TMS conditions. A difference between Go and NoGo MEPs was limited to No-Food

images but absent for Food conditions. Discussion: Overall, we show faster RTs and higher accuracy for the High-calorie stimuli. Both behavioural and neurophysiological measures point at a differential modulation when targeting inhibitory control, in favour of the more appetizing food category (High-calorie). Moreover, the observed modulation of behavioural measures under TMS conditions suggests a crucial involvement of the motor network in this process. Conclusions: In healthy individuals, the sight of food elicits distinctive motor tendencies regulated by both homeostatic (food vs. no food stimuli) and hedonic (high-calorie vs. low-calorie stimuli) mechanisms. Future work will explore to what extent these processes are affected in eating disorders.

The effects of olfactory stimulation in patients with acquired brain injury

Giulia Piccinini, R. Fiori, C. Pazzaglia, L. Padua

Abstract

Objectives: Evidence on treatments that promote arousal in patients with acquired brain injurie (ABI) is still limited. Among these, sensory stimulation could promote synaptic plasticity and prevent sensory deprivation. Studies in literature have demonstrated that olfactory stimulation is able to influence emotional and cognitive processes (attention, memory, language), motor control and Autonomic Nervous System (ANS) response in healthy subjects. In patients with ABI, the use of olfactory stimulation in the recovery process is still limited and its effect on awareness and ANS response has not been clarified yet. The aim of the study is to investigate, in healthy subjects and in patients with ABI, the effects of olfactory stimulation on ANS.
Materials and Methods: Seven patients with ABI and seven healthy subjects were recruited and underwent olfactory stimulation using a natural smell, mint, and a neutral smell, water. The stimulation with the natural smell was preceded and followed by the administration of the neutral smell and the whole stimulation cycle was preceded and followed by a rest period. To assess ANS response, Heart Rate Variability (HRV) was recorded using an ECG holter, across all the stimulation period and the and the considered parameters were LF, HF and their ratio (LF/HF). Results: In healthy subjects, we observed an initial prevalent activation of the Sympathetic Nervous System (SNS) in rest phase immediately before administration of the neutral smell followed by a significant activation of the Parasympathetic Nervous System (PNS) during the administration of water (p=0,043) and then by a significant activation of the SNS during the administration of mint (p=0,04). In patients with ABI, only a significant activation of SNS during olfactory stimulation with mint was observed (p=0,04). Discussion and conclusion: Our results show a different response to olfactory stimulation in the two groups. In healthy subjects a significant activation of the ANS was observed, both during the rest phase, before stimulus administration, and the natural stimulus administration phase. In patients, a significant activation of the ANS only during the real olfactory stimulus administration was observed. Our preliminary results suggest that olfactory stimulation can be used in rehabilitation settings with the aim of improving vigilance and awareness in patients affected by ABI.
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Live effects of anodal and cathodal transcranial Direct Current Stimulation (tDCS) on glucose metabolism in a patient with chronic hemorrhagic stroke: a FDG-PET study

Giuseppe Reale, A. Fusco, F. Cocciolillo, V. Amoruso, D. Glorioso, L. Castelli, M. Calcagni, L. Padua

Abstract

Objective. Transcranial direct current stimulation (tDCS) is a non-invasive brain stimulation technique, also used to enhance recovery during stroke rehabilitation. Stimulation of the affected hemisphere with anodal-tDCS or inhibition of the unaffected hemisphere with cathodal-tDCS are two possible approaches. However, evidence of the live effects of tDCS on brain activity is still limited. It has been pointed out that brain positron emission tomography (PET) might represent a potential neuroimaging technique to explore the role of tDCS in brain metabolism modulation. Currently, there is no study assessing the direct effect of tDCS on brain metabolism using brain PET in chronic stroke patients. The purpose of this study is to evaluate whether and how tDCS, in its anodal and cathodal application, induces acute changes in brain metabolism in a patient with chronic stroke. Materials. We recruited a patient with chronic hemorrhagic stroke admitted to our Intensive Neurorehabilitation Care. The patient was a 61 years old male, with no previous medical condition except of arterial hypertension. Methods. The patient underwent to the following protocol: (i) baseline cerebral FDG-PET (T0), two weeks after admission; (ii) cerebral FDG-PET during anodal-tDCS on the affected hemisphere, four weeks after admission (T1), (iii) FDG-PET during cathodal-tDCS on the unaffected hemisphere six weeks after admission (T2). tDCS was performed for 20 min at 2 mA on the primary motor cortex, soon after FDG administration, during PET imaging acquisition. Results. At baseline FDG-PET brain, marked hypometabolism of the right nucleocapsular hemorrhagic lesion was documented. At T1 (anodal-tDCS), brain metabolism appeared increased in the hemisphere contralateral to the stimulated hemisphere, with minimal concomitant reduction in the ipsilateral hemisphere. Finally, at T2 (cathodal-tDCS), brain metabolism appeared reduced in the hemisphere ipsilateral to the inhibitory current applied by tDCS. Discussion. As far as we know, this is the first reported case of brain metabolism changes induced by tDCS evaluated by FDG-PET in a patient with chronic stroke. The brain metabolism modulation during cathodal-tDCS was consistent with the expected inhibitory effect of the cathodal current applied. On the opposite, the effect of anodal-tDCS was different than expected, with a widespread activation of the contralateral, unaffacted hemisphere.
Conclusions. FDG-PET can detect the live effect of tDCS on brain metabolism and could help to tailor the best tDCS approach for each patient. References: Lefaucheur JP, Antal A, Ayache SS, Benninger DH, Brunelin J, Cogiamanian F, Cotelli M, De Ridder D, Ferrucci R, Langguth B, Marangolo P, Mylius V, Nitsche MA, Padberg F, Palm U, Poulet E, Priori A, Rossi S, Schecklmann M, Vanneste S, Ziemann U, Garcia-Larrea L, Paulus W. Evidence-based guidelines on the therapeutic use of transcranial direct current stimulation (tDCS). Clin Neurophysiol. 2017 Jan;128(1):56-92. Rudroff T, Workman CD, Fietsam AC, Ponto LLB. Imaging Transcranial Direct Current Stimulation (tDCS) with Positron Emission Tomography (PET). Brain Sci. 2020 Apr 15;10(4):236.
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Tracking the effects of transcranial direct current stimulation (tDCS) on cortical excitability by means of TMS-EEG

Leonor Josefina Romero Lauro, E. Varoli, A. Vergallito, A. Pisoni, L. Del Mauro, G. Mattavelli, G. Vallar

Abstract

Despite tDCS is increasingly used in experimental and clinical settings, the neurophysiological underpinnings of its effects remain unclear. Moreover, polarity-dependent effects are well documented in the sensorimotor domain but are still controversial when higher cognitive functions are targeted. We used an integrated system of Transcranial Magnetic Stimulation and Electroencephalography (TMS-EEG) to track the modulation of cortical excitability induced by either anodal (a-) or cathodal (c-) tDCS on healthy subjects, while resting or during task execution. In two studies, the effects of tDCS were explored during resting state, targeting with TMS the left posterior parietal cortex (PPC), before, during, and after either a- or c-tDCS over the right PPC.

In another pair of studies, the effects of tDCS were explored during task execution. For a-tDCS, the anode was applied over the left inferior frontal gyrus while a verbal fluency task was performed. For c-tDCS, the right PPC was targeted, while participants performed a Posner spatial attentional task. In all studies, the EEG was concurrently recorded from 60 channels and each participant underwent an additional control session with Sham tDCS. Indexes of global and local cerebral excitability were computed (Global Mean Field Power and Local Mean Field Power) on mean TMS-evoked potentials. A source modeling analysis was also performed, to better define the localization of the induced aftereffects, avoiding the potential confound of volume conduction. Regarding a-tDCS, at resting state a widespread rise of cortical excitability was detected along a bilateral frontoparietal network, likely following structural connections. At an active state, instead, a-tDCS induced a more focal increase of excitability, confined to the brain areas involved in the task execution, namely left Brodmannâ€™s areas 6, 44, and 45, which are key areas of the language production network. Interestingly, a significant correlation between enhancement of verbal fluency performance and increment of cortical excitability was found, thus relating the behavioral results with tDCS neuro-physiological effects. For c-tDCS, whereas at resting state both sensors and cortical sources results converged in showing no significant modulation of cortical excitability compared to sham stimulation, at an active state a significant reduction of cortical excitability was found in the brain areas involved in task execution. These data highlight an asymmetric impact of anodal and cathodal stimulation on cortical excitability and suggest that the aftereffects of both polarities are state-dependent. These results have relevant implications for tDCS set up both in cognitive neuroscience experiments and rehabilitation protocols.

Spatiotemporal Specificity of TMS-evoked Potentials versus Sensory Evoked Potentials

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Abstract

Obiettivo: To test whether real-time visual optimization of EEG potentials evoked by Transcranial Magnetic Stimulation evoked potentials (TEPs) may, along with the application of experimental procedures designed to control for sensory confounding factors, lead to TEPs with spatiotemporal features that are specific for the TMS cortical target. To this aim, we systematically compared TEPs recorded by targeting two cortical sites with EEG potentials evoked by realistic sham stimulations. Materiali e metodo: Twelve healthy subjects (n=12) participated in the study. EEG was recorded by means of a TMS-compatible 64-channel amplifier. MRI-guided TMS was delivered through a biphasic figure-of-eight coil. TMS parameters were fine-tuned in each measurement by monitoring in real time the EEG responses in order to prevent scalp muscle activations and maximize the signal-to-noise ratio of early TEP components. The left premotor cortex and the left primary motor cortex (hand motor knob, at sub-threshold intensity for peripheral muscle activation) were targeted. An adapted noise masking was continuously played through inserted earplugs. For each stimulation target, two types of sensory sham stimulations were performed: i) one scalp electrical stimulation at an intensity comparable to the real TMS with the coil in sham mode (realistic sham) and noise masking; ii) one stimulation with the coil in sham mode without noise masking (auditory sham). After data preprocessing [Fecchio et al., Plos One 2017], TEPs and EEG responses to sham stimulations were compared in both time and space. Risultati: TEPs at premotor and motor sites are qualitatively and quantitatively different, retaining waveforms and overall spatiotemporal dynamics that are specific for the site of stimulation beyond 200 ms. Conversely, auditory sham stimulation evokes EEG potentials that are invariably dominated by two late unspecific components, one negative at ~100 ms and one positive at ~200 ms, that are largest over central derivations irrespective to the site of stimulation. Similarly, electrical sham stimulation results in only minor, unspecific central components with similar latencies, with an amplitude that increases as a function of the stimulation intensity. Interestingly, these central late components were reduced in the multimodal stimulation compared to the ones evoked by the electrical stimulation alone at the same intensity. Discussione e Conclusioni: When real-time visual optimization of TEPs and state-of-the-

art experimental procedures are employed, TEPs display spatiotemporal features that are specific for the stimulation site and hence can be safely regarded as genuine cortical responses to a direct stimulation. References: Fecchio et al., The spectral features of EEG responses to transcranial magnetic stimulation of the primary motor cortex depend on the amplitude of the motor evoked potentials. PLoS One. 2017 Sep 14;12(9):e0184910. doi: 10.1371/journal.pone.0184910. eCollection 2017.

Somatosensory down-regulation following the rubber hand illusion: a predictive coding account

Alice Rossi Sebastiano, S. Gualtiero, K. Poles, I. Ronga, C. Fossataro, F. Garbarini

Abstract

The sense of body ownership (i.e., the feeling that different body-parts belong to ourselves), can be experimentally manipulated in healthy subjects by means of the rubber hand illusion (RHI [1]). In the RHI, the synchronous stroking of the participant's (hidden) hand and a visible rubber hand induces an illusory feeling of embodiment towards the fake hand. Within the predictive coding framework, it has been suggested that the RHI emerges through the attenuation of somatosensory precision, as an attempt to settle the visuo-tactile conflict [2,3]. Here, we sought for evidence of the embodiment-dependent down-regulation of somatosensory activity, shedding light on its specific time dynamics. Seventeen healthy participants underwent two sessions, in which we administered 100 trials combining 12 seconds of RHI (synchronous/asynchronous according to the session) with one electrical stimulus delivered over the right median-nerve. Note that illusory embodiment is elicited only in the synchronous session, whereas the asynchronous one served as control. Two-tailed paired t-tests were run on mean amplitudes of early and late components of somatosensory evoked potentials in centroparietal and frontocentral contralateral clusters to compare synchronous and asynchronous conditions. Furthermore, time-frequency decomposition for the alpha frequency band was calculated and event-related percentage change in oscillation amplitude relative to a baseline (%ER) was entered in a two-tailed paired t-test comparing synchronous and asynchronous conditions. Results revealed a significant difference both in the short-latency N60 component in a centroparietal cluster [$t(1,16)=2.65$; $p=0.01$] and in the long-latency P300 component in centroparietal [$t(1,16)=2.21$; $p=0.04$], and frontocentral [$t(1,16)=2.93$; $p=0.01$] clusters with smaller amplitude in the synchronous condition, reflecting the embodiment-dependent down-regulation. Moreover, the t-test on %ER revealed a significant difference in a frontocentral contralateral cluster, showing a significant decrease in post-stimulus alpha-band desynchronization in the synchronous as compared to the asynchronous condition [$t(1,16)=-4.09$; $p=0.001$] in a long-latency range (300-400 ms). This result provides further evidence of somatosensory down-regulation, since somatosensory-related alpha attenuation reflects the excitability of sensorimotor cortices. Altogether, the present findings highlight an embodiment-dependent down-regulation affecting both early and late stages of somatosensory processing, in line with the predictive coding account of the RHI. According to this interpretation, to explain away the multisensory conflict between visual and somatosensory input, the brain should reduce the weight afforded to somatosensory input via a top-down modulation operated on primary sensory areas. References: Botvinick, M. & Cohen, J. Rubber hand feels touch that eyes see. Nature, (1998) 391, 756. Zeller, D., Friston, K. J. & Classen, J. Dynamic causal modeling of touch-evoked potentials in the rubber hand illusion. Neuroimage, (2016) 138, 266-273. Zeller, D., Litvak, V., Friston, K. J. & Classen, J. Sensory Processing and the Rubber Hand Illusion-An Evoked Potentials Study. J. Cogn. Neurosci., (2014) 27, 1-10.

Indicaxanthin is able to modulate human motor cortical excitability and plasticity

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Abstract

Objectives: There is evidence about bioactive role of phytochemicals in physiopathological pathways, such us implications in inflammation and oxidative stress. Nevertheless, it is still to be investigated their putative influence on neuronal processes. The study of cortical excitability and plasticity could shed light on the interaction between nutraceuticals and neuronal circuits in human brain. Considering this, our focus is Indicaxanthin (IX), a betalaine pigment known to be able to cross the blood brain barrier (BBB) and have effects on neuronal excitability in rats (1). An important source of this antinflammatory and antioxidant nutraceutical is Opuntia Ficus Indica, employed for our experimental approach, to verify whether the administration of IX has acute effects on cortical excitability and plasticity. Materials: We recruited 8 healthy and right-handed male subjects (20-45 years) with no history or clinical signs of neurological diseases, brain trauma or use of drugs able to affect cortical excitability, as a clinical neurologist assessed. Non-Invasive Brain Stimulation and Neuromodulation (NIBS and NIN) protocols were rigidly applied in their safety guidelines, inclusion criteria and operating instructions (2). Methods: Each subject underwent 30 stimuli of paired pulse transcranial magnetic stimulation ppTMS (Magstim Co, Dyfed UK) and anodal transcranial Direct Current Stimulation a-tDCS (tDCS, Neuroconn, Ilmenau, Germany) for 20 minutes, the former both before (PRE-tDCS) and after (POST-tDCS) the latter (3). The ppTMS set was composed by 10 short intracortical inhibition (SICI), 10 intracortical facilitation (ICF) and 10 test stimuli (TEST). All the stimuli were pseudorandomised and delivered over the M1. The same experimental procedure was applied in basic condition (T0) and 2 hours after having assumed 400 gr of cactus pear fruits (T1), at least over one week distance. Results: IX increased PRE-TDCS TEST ($p<0.0103$) and PRE-TDCS ICF ($p<0.052$) significantly, whereas POST-TDCS ICF ($p<0.0001$) and SICI ($p<0.001$) were reduced. Lastly, PRE-TDCS SICI was unchanged. Discussion: Our data provide evidence that IX can modulate the bioelectric activity in the brain, since it is able to increase cortical excitability of human motor cortex. The paradoxical effects after tDCS may support the idea that IX achieves an excitatory drive leading to homeostatic responses on motor cortical plasticity. Conclusion: This study contributes to the idea that this nutraceutical could be employed for further investigation on human brain, putatively modulating several neuronal processes that impact on brain excitability. References: Gambino G, Allegra M, Sardo P, Attanzio A, Tesoriere L, Livrea MA, Ferraro G, Carletti F. Brain Distribution and Modulation of Neuronal Excitability by Indicaxanthin From Opuntia Ficus Indica Administered at Nutritionally-Relevant Amounts. Front Aging Neurosci. 2018 May 9;10:133. doi: 10.3389/fnagi.2018.00133. eCollection 2018. PMID: 29867444 Rossi S, Antal A, Bestmann S, Bikson M, Brewer C, BrockmÃ¶ller J, Carpenter LL, Cincotta M, Chen R, Daskalakis JD, Di Lazzaro V, Fox MD, George MS, Gilbert D, Kimiskidis VK, Koch G, Ilmoniemi RJ, Lefaucheur JP, Leocani L, Lisanby SH, Miniussi C, Padberg F, Pascual-Leone A, Paulus W, Peterchev AV, Quartarone A, Rotenberg A, Rothwell J, Rossini PM, Santarnecchi E, Shafi MM, Siebner HR, Ugawa Y, Wassermann EM, Zangen A, Ziemann U, Hallett M; basis of this article began with a Consensus Statement fr Brighina F, De Tommaso M, Giglia F, Scalia S, Cosentino G, Puma A, Panetta M, Giglia G, Fierro B. Modulation of pain perception by transcranial magnetic stimulation of left prefrontal cortex. J Headache Pain. 2011 Apr;12(2):185-91. doi: 10.1007/s10194-011-0322-8. Epub 2011 Feb 25. PMID:Â 21350791

TMS Adaptable Auditory Control: a universal tool to mask TMS click

Simone Russo, S. Sarasso, A. Pigorini, G. Puglisi, D. Dal Palù, A. Astolfi, M. Massimini, M. Rosanova, M. Fecchio

Abstract

Introduction: Coupling Transcranial magnetic stimulation (TMS) with electroencephalography (EEG) allows to non-invasively probe the thalamocortical system. However, obtaining a pure TMS evoked potential requires controlling for several confoundings, such as auditory potentials evoked (AEPs) by the 'click' generated by the TMS discharge. An effective control for AEPs consists of delivering a noise through earphones to mask the TMS 'click'. Here we quantify the sound level of the noise required to mask the TMS 'click' and provide TMS Adaptable Auditory Control (TAAC), a tool that generates in real-time a masking noise adapted to the stimulator and optimized to fit the â€˜clickâ€™ perception. Materials: TMS employed

a Focal Bipulse figure-of-eight coil (50/70 mm, eXimia Stimulator, 70% of the maximum intensity). The masking noises were administered through in-ear earphones (JVC HA-FX8) and acquired through microphones in a Head and Torso Simulator (Bruel&Kjaer, Type4128; HATS). EEG data were acquired through a 62-channel TMS-compatible BrainAmp DC-amplifier. Methods: We measured the sound level required to mask the TMS â€˜clickâ€™ with the state-of-the-art (i.e. white noise[1] and adapted noise[2]) and with two noises created through TAAC. In 19 subjects we delivered TMS pulses while gradually increasing the loudness until the subject was not able to identify the TMS 'click'. This procedure was iteratively performed with for all noises and during a real TMS condition (TMS 2 cm posteriorly to the vertex) and a sham TMS condition (TMS on the vertex, tilted 90Â° on the sagittal plane). Conditions and masking noises were randomly shuffled across subjects. Each masking noise was delivered to the HATS, measuring the resulting equivalent sound level. Results: Our results show that all masking noises were effective at sound levels within the safety range for the usual duration of TMS-EEG measurements (Medians: White noise=87.1Db; Adapted noise=88.9Db; TAAC Noise1=84.1Db; TAAC Noise2=82.9Db). The noises created through TAAC reduced the sound level required to mask the TMS 'clickâ€™. Discussion: The sound level required to mask TMS 'click' has been questioned in previous TMS-EEG studies[3]. By quantifying it, we demonstrate that this procedure is safe for the human auditory system. Moreover, the duration of safe exposure to these sound levels with respect to standard safety tables is largely below the typical duration of TMS-EEG procedures. Conclusions: Masking the TMS 'click' through noise is a safe procedure. Furthermore, masking noises created through TAAC can mask TMS 'click' with more comfort for the subject with respect to state-of-the-art masking procedures. References: T. Paus, P.K. Sipila, A.P. Strafella Synchronization of neuronal activity in the human primary motor cortex by transcranial magnetic stimulation: an EEG study J Neurophysiol, 86 (2001), pp. 1983-1990 M. Massimini, F. Ferrarelli, R. Huber, S.K. Esser, H. Singh, G. Tononi Breakdown of cortical effective connectivity during sleep Science, 309 (2005), pp. 2228-2232 V. Conde, L. Tomasevic, I. Akopian, K. Stanek, B. Guilherme The non-transcranial TMS-evoked potential is an inherent source of ambiguity in TMS-EEG studies Neuroimage, 185 (2018), pp. 1-35.

The neurophysiology of mutual support when sharing a goal

Lucia Maria Sacheli, M. Musco, E. Zazzera, G. Banfi, E. Paulesu

Abstract

Aims. Sharing a goal is at the roots of human cooperation. It drives expectations on our partnersâ€™ behavior, makes predictive adjustments possible, and optimizes social goal achievement through mutual adaptations. However, little is known about the neurocognitive mechanisms enabling immediate adjustments during an interaction. Here, we explored these mechanisms by combining a novel musical behavioral paradigm with univariate and multivariate fMRI data analysis. We tested the hypothesis of a â€˜dyadicâ€™ organization of motor planning up to the level of an â€˜interaction monitoringâ€™ system that would ensure fast detection of a partnerâ€™s mistake and enable mutual support during cooperation.
Materials and Methods. Twenty-four healthy participants took part in a music-like paradigm. During fMRI, they played with a virtual partner short â€˜melodiesâ€™ (sequences of four notes) by performing one note each in turn-taking. A colored cue indicated which melody they had to execute at each trial, thus generating expectations on what notes the partner would play. The violation (introduced in 50% of the trials) of the partnerâ€™s association between the response buttons and the produced notes created two types of partnerâ€™s errors: the partner either played a wrong note (Outcome-Errors) or played the expected note with an unexpected action (Action-Errors). To ensure that our inferences were specific for interactions, the participants also performed the task in a perceptually matched Non-Interactive context lacking the crucial element of a shared goal. Results. Our findings reveal the existence of an â€˜interaction monitoring systemâ€™ that includes areas in both the human homologous of the fronto-parietal â€˜mirrorâ€™ network and the cingulo-opercular network responsible for adaptive responses after error execution. First, we show that these areas can decode specific violations in the partnerâ€™s expected behavior, but only when agents share a common goal. Second, we demonstrate that the neural activity in a

sub-set of these regions, comprising the posterior medial frontal cortex and the frontal opercular and anterior insular cortices, is parametrically associated with the participantsâ€™ behavioral adaptations to the partnerâ€™s errors. Finally, within this network, the right frontal opercular cortex activity predicted the agentsâ€™ tendency to correct their partnerâ€™s mistake. Discussion and Conclusions. We will discuss how this minimalistic characterization of pro-social tendencies during motor interactions, at the level of very simple gestures, provides a scalable model that opens new avenues for studying the defining traits of efficient social exchanges.

Spinal cord simulation in the treatment of neuropathic pain: how to determine its effectiveness

Ferdinando Sartucci

Abstract

Rationale and background: Spinal Cord Stimulation (SCS) represent an option for neuropathic pain treatment and several technological modalities, as high frequency (HF) and Theta Burst Stimulation (TBS), have shown promising results, although putative mechanisms of action and how to choose the best modality are still debated. We used Laser Evoked Potentials (LEPs) to test effectivity of different modalities. Methods: Thirty patients with lower back pain were enrolled and underwent LF, HF and TBS. LEPs were recorded by using a Nd: YAG laser: amplitudes and latencies of the main two components (N1, N2/P2) were compared among different experimental conditions to establish the most effective. Similarly, changes in Resting Motor Threshold (RMT), cortical Silent Period (cSP), Short Intracortical Inhibition (SICI) and Intracortical Facilitation (ICF) were evaluated. Results: TBS dampened LEP amplitudes compared with LF (N1: p = 0.016; N2/P2: p = 0.02) and HF stimulation (p = 0.015; p = 0.031); while RMT and SICI did not change among experimental conditions, TBS signicantly prolonged cSP duration compared with baseline (p = 0.002), LF (p = 0.048) and HF-SCS (p = 0.016); both HF (p = 0.004) and TBS (p = 0.0039) increased ICF. Discussion and Conclusions: TBS modulates the sensory-discriminative and the affective-emotional dimension of pain through distinct mechanisms, thus involving intracortical GABAergic and Glutamatergic networks. These results have implications for therapy, for the choice of the stimulation protocol and asses its effectiveness.
Key point 1: electrical neuromodulation by spinal cord stimulation (SCS) is commonly employed in the treatment of neuropathic pain; Key point 2: mechanisms of action and the most effective modality of SCS are few known; Key point 3: we investigated mechanism of action trough analysis of LEPs changes produced by SCS; Key point 4: theta burst stimulation resulted more effective than low and high frequency stimulation.
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Differences in Spatial navigation and spatial memory in athletes and non-athletes: a pilot task on spatial-olfactory navigation

Tonia Serio, M. Salonna, F. Fancello, G. Accogli, M. Leucci, D. Lankford, S. Invitto

Abstract

Many studies focused on navigation, spatial skills and olfactory system in comparative models, including those concerning the relationship between them and physical activity. Although the results are often in contrast with each other, it is assumed that physical activity can affect cognition in different ways - both indirectly and through a certain influence on some brain structures. In contrast, there is little research that focuses on the relationship between spatial abilities and olfactory abilities in humans. This research aims to evaluate and compare the performance in working memory tasks of athletes and non-athletes who require good skills of visual-spatial navigation, olfactory-spatial navigation, and olfactory-semantic skills. The study

involved 236 subjects (83 athletes) between the ages of 18 and 40, subjects. All subjects were matched by age or sex. The standard Corsi Block Tapping Test (CBTT) was used to examine visual-spatial memory. Olfactory-spatial navigation and olfactory-semantic skills were assessed with two modified versions of CBTT: Olfactory CBTT (OCBTT) and Semantic-Olfactory CBTT (SOCBTT) respectively. The results show a positive correlation between sports activity and the different modalities of tasks and generally better performance for athletes. A gender effect in favor of men was also found, in particular, in the classic version of CBTT. Both groups had a better performance in the classic version of the CBTT than OCBTT and SOCBTT. The mean of the results of the SOCBTT is markedly lower, perhaps due to the implication of different information processing systems needed to perform this kind of task. As also reported in the literature, a gender effect was also found. Men, in both groups, performed better than women in the classic variant of the CBTT, while no significant difference was found in the performance of the other two tasks. Moreover, more specifically, it is possible to observe that non-athlete men and women perform better in carrying out the task than men and women athletes. It is possible to explain how sports practice can affect differently on tasks that require the use of spatial skills and olfactory perception, thus supporting new hypotheses and opening new scientific horizons.
Keywords: Spatial Navigation â^™ Spatial Representation â^™ Spatial Memory â^™ Olfaction â^™ Physical activity â^™ Sport â^™ Corsi Block Tapping Test.

Vision and hearing share a common representation in STS despite the lack of multisensory experience

Francesca Setti, G. Handjaras, A. Leo, M. Diano, V. Bruno, C. Tinti, L. Cecchetti, D. Bottari, F. Garbarini, P. Pietrini, E. Ricciardi

Abstract

Background and Aim. Integration of signals from multiple sources over time is fundamental to make sense of the world around us. Basic multisensory functions are present from earliest developmental stages while more complex ones rely to a greater extent on sensory experience [1]. Here we investigated whether and to what extent vision and hearing share a common representation despite the lack of multisensory experience, as in congenital visual and auditory deprivation. We adopted naturalistic stimulation, as conveying complex information across audio-visual channels [2], and the Inter-Subject Correlation (ISC), as a measure of synchronicity of fMRI responses across subjects [3]. Materials and Methods. A multisensory (AV) and two coherent unimodal (V-only and A-only) versions of the 101 Dalmatians movie were employed. Brain activity was acquired using 3T fMRI in: i) typically developed (TD) individuals who were presented with either the audio-visual (AV, n=10) movie or one of the two unimodal versions (A-only, n=10; V-only, n=10); ii) congenitally blind subjects (CB, n=9) listening to the A-only version and iii) congenitally deaf (CD, n=9) participants watching the V-only version of the movie. We computed a whole-brain within-group ISC among participants exposed to the AV condition, and an across-modalities ISC (A vs V) in both TD and sensory deprived (CB and CD) individuals. Statistical analyses relied on non-parametric permutation tests with FWE correction ($p<0.05$). Results. We found that the bilateral superior temporal sulcus (STS) and neighbouring regions (comprising the precuneus and the parieto-occipital cortex) were commonly engaged i) during the processing of multimodal (AV) information and ii) across the presentation of unimodal (A-only and V-only) stimuli, not only in TD individuals but also in congenitally deprived subjects, who lack multisensory experience since birth. Moreover, the inferior-temporal, inferior-parietal and right-dorsal prefrontal cortices were significantly synchronized both in TD and in congenitally deprived participants. Discussion and Conclusions. Here we investigated the functional organization of classical multisensory areas by comparing ISC during multimodal AV in TD and across unimodal streams (A vs V), both in TD and sensory deprived individuals. A set of regions synchronizes their responses over time to visual and acoustic input even during unimodal processing, and, most importantly, despite a congenital visual or auditory deprivation. This was particularly evident in the superior temporal cortex (STS), whose activity during the A-only condition in blind synchronizes with the activity during the V-only condition in deaf subjects.

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Dissociating the roles of the motor cortex and cerebellum in muscle pattern organization

Danny Adrian Spampinato, D. Berger, A. D'Avella, G. Koch

Abstract

Performing daily-life movements in a controlled manner requires the careful coordination and activation of several muscles patterns that are irrespective of time (spatial synergies), in time irrespective of the muscles (temporal synergies), and both across muscles and in time (spatiotemporal synergies). Preliminary work has shown that spatiotemporal but not spatial synergies are compromised in patients with cerebellar damage, yet the role of cortical regions and how they interact with cerebellar regions to coordinate multi-muscle patterns remains unclear. Here, we ask whether spatial, temporal, or spatiotemporal synergies are exclusively affected when disrupting either the primary motor cortex (M1) or cerebellum in healthy individuals. In a randomized, sham-controlled, cross-over design, we applied continuous theta-burst stimulation (cTBS) either over the cerebellum or M1 and assessed whether spatial and temporal aspects of muscle patterns during simple reaches are affected by stimulation. We recorded electromyographic activity from 13 shoulder and arm muscles in 12 healthy participants while they performed goal-directed reaching movements in multiple directions. We assessed whether stimulation affects the organization of muscle patterns by extracting synergies from the muscle patterns of each individual and used these synergies to reconstruct the muscle patterns of all other participants. We found that cerebellar cTBS produced significant differences in the reconstruction R2 values for both spatiotemporal and temporal synergies, with an interaction between the two synergy types indicating a larger difference for spatiotemporal synergies. On the other hand, M1 cTBS elicited significant decreases in R2 reconstruction values for spatiotemporal and spatial synergies. These results indicate that the cerebellum and M1 have dissociable roles in the spatial and temporal organization of muscle patterns that are necessary for daily-life reaches. We aimed at gaining new insights on the neural organization of the muscle patterns for reaching by disrupting cerebral and cerebellar processes with plasticity-inducing cTBS. Understanding the specific roles of distinct brain regions in muscle pattern organization is highly relevant for upper limb rehabilitation because it may lead to the development of novel diagnostic and therapeutic interventions aimed to improve specific aspects of motor function in neurological patients. We provide evidence for spatial and temporal changes in muscle patterns following non-invasive brain stimulation applied to healthy individuals. These changes capture specific modifications in the coordination strategies, suggesting a critical and separate role of the cortex and cerebellum in the generation of muscle movement patterns.

Fear in action: how Pavlovian acquired fear shapes the control of voluntary movement

Francesca Starita, S. Garofalo, L. Degni, D. Dalbagno, G. Di Pellegrino

Abstract

During Pavlovian fear learning, intrinsically neutral stimuli acquire fear related value by being repeatedly paired with an aversive event. Importantly, although no overt motor response is required during learning, changes in behavior are generally included among the markers of successful learning [1]. Nevertheless, in humans, whether and how Pavlovian acquired fear actually changes motor response has received little investigation [2]. To test this, thirty-four participants performed reaching movements toward two different neutral stimuli while movement kinematics was recorded (baseline phase). A Pavlovian fear learning phase followed, during which one stimulus was paired with an aversive shock (i.e. conditioned stimulus, CS+), while the other was used as a control (i.e. CS-). Then, participants repeated the initial reaching movements

(test phase). Results showed that the acquisition of fear related value by the CS+ during Pavlovian learning exerted a powerful influence on subsequent movement kinematics. At test, the vigor (i.e. peak velocity and acceleration) of participantsâ€™ motor response increased when reaching towards CS+ as compared to CS-. Crucially, this increase in vigor manifested both under threat of shock â€“ i.e. when shock electrodes were attached to the wrist, but the shock was never delivered â€“ as well as under no threat â€“ i.e. when no electrodes were attached. Additionally, the increase in vigor was predicted by the strength of fear learning. The stronger participantsâ€™ arousal (i.e. skin conductance response) was during learning for the CS+ relative to the CS-, the greater was the increase in vigor. These results indicate that Pavlovian acquired fear indeed shapes the control of voluntary movement, although its acquisition occurred in the absence of overt motor responses, and that its effect persists even in the absence of an actual threat. Such changes in motor behavior may reflect distinct and so far unknown aspects of Pavlovian learning, contributing to the understanding of adaptive and potentially maladaptive forms of learning, such as anxiety disorders. References: Lonsdorf, T. B., Menz, M. M., Andreatta, M., Fullana, M. A., Golkar, A., Haaker, J., Heitland, I., Hermann, A., Kuhn, M., Kruse, O., Meir Drexler, S., Meulders, A., Nees, F., Pittig, A., Richter, J., RÃ¶mer, S., Shiban, Y., Schmitz, A., Straube, B., â€¦ Merz, C. J. (2017). Donâ€™t fear â€˜fear conditioningâ€™: Methodological considerations for the design and analysis of studies on human fear acquisition, extinction, and return of fear. In Neuroscience and Biobehavioral Reviews (Vol. 77, pp. 247â Beckers, T., Krypotos, A. M., Boddez, Y., Effting, M., & Kindt, M. (2013). Whatâ€™s wrong with fear conditioning? Biological Psychology, 92(1), 90â€“96. https://doi.org/10.1016/j.biopsycho.2011.12.015.

Facial kinematics of genuine and simulated fear

Elisa Straulino, A. Miolla, C. Scarpazza, L. Sartori

Abstract

We often make facial expressions to convey an emotional message, but it does not mean that we sincerely feel this emotion. Sometimes, we pretend to express happiness, disgust, or fear as actors usually do. Past research investigating emotional displays has mainly focused on facial muscle activation using manual coding approaches, such as the Facial Action Coding System (FACS). Although this is the most widely used method to categorize emotion expressions, its primary drawback is that it analyzes each facial movement independently from other movements. Moreover, research on facial expression is mainly based on static and simulated pictures, without considering genuine and dynamic changes of the face. The true move towards an objective analysis of emotional function is the 3-D tracking of genuine facial expressions. Here, we extracted temporal, spatial, and speed parameters of fear expressions to reveal the inner syntax of emotional language. Twenty naÃ¯ve participants were requested to watch scary videos that triggered spontaneous feelings of fear. Then, they were asked to deliberately reproduce the same expressions while looking at a static picture of fear (posed expression). For both genuine and posed expressions, kinematic profiles of facial movements were recorded by means of six infra-red cameras using a 3-D motion analysis system. We found a range of cues characterising and distinguishing genuine from posed expression facial cues. For instance, genuine expressions of fear are characterized by greater amplitude and higher velocity peaks, but the time required to reach the maximum extension of the mouth is longer compared to the posed one. In practical terms, these results provide a decisive step forward for the detection of facial deceptive cues and the creation of large databases of genuine and posed expressions for multidisciplinary future studies. References: Ekman, P. & Friesen , W. (1978). The facial action coding system. Palo Alto: Consulting Psychologists Press. Sowden, S., Schuster, B. A., Keating, C. T., Fraser, D. S., & Cook, J. L. (2021). The role of movement kinematics in facial emotion expression production and recognition. Emotion. http://dx.doi.org/10.1037/emo0000835

Age-Related Neural Changes of Inter- and Intra-Hemispheric EEG Activity in Visuo-Spatial Working Memory

Chiara Tagliabue, G. Varesio, V. Mazza

Abstract

Background. Older adults exhibit a tendency to recruit supplementary brain areas while performing several cognitive tasks. According to two of the most influential models of neurocognitive aging, namely the Hemispheric Asymmetry Reduction in Older Adults (HAROLD; Cabeza, 2002) and the Posterior-Anterior Shift in Aging (PASA; Davis et al. 2008), such age-related brain changes include supplementary activations in bilateral (according to HAROLD) and frontal (according to PASA) areas. Aim. We aimed to test whether the two models of neurocognitive aging could explain the differences observed between young and old adults in the EEG responses elicited by a paradigm that is commonly used to asses visuo-spatial working memory (vWM) capacity, a cognitive ability that is susceptible to a dramatic reduction with aging (Tagliabue et al., 2019. Materials and Methods. Young (N = 36; mean age = 24) and older (N = 35; mean age = 70) adults performed a lateralized delayed match-to-sample task with three different memory loads (1, 2, 4), while their EEG signal was simultaneously recorded. We interpreted the modulations as a function of memory load as a proxy of the neural efficiency in discriminating to-be-memorized items. Specifically, we compared load-related contra- and ipsi-lateral (to test for HAROLD) and posterior and anterior (to test for PASA) activity, between the two age groups. Results. At the behavioral level, young adults outperformed the elderly, who showed overall a lower vWM limit. Data-driven whole scalp EEG analysis showed that the processing of the different memory loads resulted in additional bilateral posterior and frontal engagement in the older group, thus supporting both HAROLD (bilateral activity) and PASA (frontal activity) predictions. Discussion. Despite the fact that elderly activated additional bilateral and frontal brain sites, this supplementary neural engagement was not compensatory, since it did not support their behavioral performance. Taken together, behavioral and EEG data better call for an age-related dedifferentiation mechanism. According to this view, the recruitment of additional cortical areas might lead to a loss of selectivity of brain responses in the elderly. Conclusions. Even if older adults recruit supplementary brain areas to perform a vWM task, such activations seem to reflect reduced neural differentiation, ultimately leading to a decrease in their vWM capacity. References: Cabeza, R. Hemispheric asymmetry reduction in older adults: The HAROLD model. Psychology and Aging, 2002, 17(1), 85â€“100. Davis, S. W., Dennis, N. A., Daselaar, S. M., Fleck, M. S., & Cabeza, R. Que PASA? The posterior-anterior shift in aging. Cerebral Cortex, 2008, 18(5), 1201â€“1209. Tagliabue, C. F., Brignani, D., & Mazza, V. Does numerical similarity alter age-related distractibility in working memory? PLOS ONE, 2019, 14(9), e0222027.

A tractography-guided TMS of the cortical origins of the frontal aslant tract (FAT)

Marco Tagliaferri, D. Giampiccolo, P. Avesani, G. Amorosino, E. Pierotti, L. Turella, S. Parmigiani, L. Cattaneo

Abstract

The dorsal and the ventral premotor regions are two independent hubs in the cortical motor system that code both the sensory representations of action targets and actual actions. In primates, both regions contain a complete upper/fore limb representation and are thought to support different types of sensorimotor processes. The dorsal region is thought to be involved in processes of action selection and action timing and the ventral premotor region is thought to support visuospatial features of the cue. These two regions are strongly inter-connected by a white matter tract, the frontal aslant tract (FAT), that defines a system of homologous regions between the superior frontal gyrus and the inferior frontal gyrus. In the present study we aim to explore with online TMS homologous sectors of the superior and inferior frontal gyri as defined by FAT connectivity during a task in which proactive and reactive action strategies can be dissociated. Our hypothesis is that proactive action strategies are mainly driven by the superior frontal gyrus (dorsal premotor system) while reactive strategies rely more on the inferior frontal gyrus. Participants underwent individual MRI scans to obtain tractographic definition of the FAT bilaterally and underwent neuronavigated transcranial magnetic stimulation (TMS) of the of the FAT over a dense grid of scalp points that covers the whole dorsal and ventral cortical terminations of the tracts. The results of the present pilot

experiment show that a specific sector of the superior frontal gyrus impacts proactive behaviour and that a complementary effect is observed by stimulating the homologous region in the inferior frontal gyrus. In conclusion, in the light of the present pilot, we suggest that A) the superior and inferior frontal gyri have complementary roles in the genesis of reactive vs proactive behaviour and B) tractography-guided TMS may greatly increase spatial-functional resolution of TMS.

Decision-making along the autism continuum: behavioural and electrophysiological evidence

Luca Tarasi, G. Di Pellegrino, V. Romei

Abstract

1. Objectives Decision-making results from a balanced integration of external input and prior knowledge. However, there are individual differences in the way prior knowledge is weighted. Current theories claim that individuals within autism spectrum (ASD) tend to discount prior information to guide behaviour1. This study aimed to assess whether differences in the use of aprioristic knowledge can also be traced in the general population according to the autistic traits and which neural processes underpin this different cognitive style. 2. Materials We used a visual detection task in which participants (n=30) received a cue signalling the probability of target presence in the forthcoming trial. EEG activity was recorded during a resting-state session while participants kept their eyes closed. All participants completed the Autistic Quotient (AQ)2. 3. Method Signal detection theory and drift-diffusion model were used to assess the impact of the probabilistic cue on behaviour. At the neural level, analyses focused on connectivity along the alpha band (weighted phase-lag and time-lag) within the fronto-posterior axis3. Moreover, we examined the relationship between behavioural as well as neural measures and AQ score. 4. Results Probabilistic cue did not significantly modulate objective performance. Conversely, both response criterion and starting point parameters were significantly shaped according to probabilistic information: response proneness closely tracked the probability of stimulus occurrence. Crucially, this relationship was attenuated according to autistic traits, such that higher AQ scores corresponded to lower response bias modulation. At the neural level, the strength of synchronization along the right fronto-posterior network was significantly correlated with both criterion modulation and autistic traits. Further confirming an inter-relationship between these indices, mediation analysis showed that the strength of occipito-frontal synchronization partly mediated the association between AQ-score and criterion modulation. Directionality analysis (time-lag) revealed that occipito-frontal synchronization was increasingly driven from bottom to top areas with higher levels of autistic traits. 5. Discussion Results demonstrate the tendency to discount aprioristic information in perceptual process as autistic traits increased, stemming from a pattern of connectivity along the anterior-posterior gradient favouring ascending information signalling. This is in line with studies showing that bottom-up visual information, transmitted via feed-forward pathways, is overweighted and less constrained by top-down prior information in ASD. 6. Conclusions These findings suggest that peculiarities in cognitive style and brain mapping are not confined to diagnosed autism but extend to the general population, thus supporting the hypothesis of a neurobiological continuum between autistic traits and ASD. References: Pellicano, E., & Burr, D. (2012). When the world becomes â€˜too realâ€™: a Bayesian explanation of autistic perception. Trends in cognitive sciences, 16(10), 504-510. Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ): Evidence from asperger syndrome/high-functioning autism, malesand females, scientists and mathematicians. Journal of autism and developmental disorders, 31(1), 5-17. Vinck, M., Oostenveld, R., Van Wingerden, M., Battaglia, F., & Pennartz, C. M. (2011). An improved index of phase-synchronization for electrophysiological data in the presence of volume-conduction, noise and sample-size bias. Neuroimage, 55(4), 1548-1565.

Impairment of Temporal Binding Window in Migraine Patients

Marta Tigano, M. Gangitano, N. Bolognini, G. Gambino, P. Sardo, F. Brighina, G. Giglia

Abstract

Objectives: The mechanisms of brain dysfunction underlying pathophysiology of migraine are yet incompletely understood but is widely accepted that migraine attack susceptibility is linked to dysregulation of cortical excitability, particularly in the visual cortex. The results of various research concerning sound-induced flash illusions (SiFi) fit into this sense. In healthy subject, the simultaneous exposure to a visual stimulus and to several auditory stimuli results in a fission error: the number of perceived flashes is greater than those actually emitted. In the migraineurs the fission illusion was reduced. Here we hypothesize that this phenomenon can be due to an altered Temporal Binding Window (TBW) of multisensorial stimuli in migraine patients. Materials and Methods: 14 patients were detected on first visit at the Headache Center of the University of Palermo and compared with 14 healthy controls. We tested participants in a dimly illuminated room; patients set 50 cm from a computer monitor with their eyes aligned to the center of the screen. Visual stimuli (white ring on a black background) and auditory stimuli (beep) were presented in different combinations: at the same time (SOA 0), with visual-preceding-auditory (SOA +) and auditory-preceding-visual (SOA -) presentations. Participants were instructed to respond as quick and as accurately as possible, whether visual and auditory stimuli were presented at the same time or in different times, using computer arrows. Results: We evaluated the Accuracy, and Response times. Migraineurs were less accurate for SOA + (p=.00) than controls. Migraineurs were globally slower than the controls (p=.00). Discussion: Multisensory integration in migraineurs can be affected by visual cortical hyperexcitability which results in a condition of hyperresponsiveness to stimuli, in particular visual ones. For this reason, when a visual stimulus is given before the auditory one (SOA+), the visual cortex could be unable to integrate the two sensory stimuli correctly, pathologically increasing the TBW during which visual stimuli are integrated with subsequent auditory ones. Conclusions: These results are in line with the Bayesian brain hypothesis, according to which, when incongruent sensory signals are perceived, the higher precision pathway is favored, which corresponds to the visual one in the migraineurs References: Brighina, F., Bolognini, N., Cosentino, G., Maccora, S., Paladino, P., Baschi, R., et al. (2015). Visual cortex hyperexcitability in migraine in response to sound-induced flash illusions. Neurology 84, 2057â€“2061. doi:10.1212/WNL.0000000000001584. Maccora, S., Giglia, G., Bolognini, N., Cosentino, G., Gangitano, M., Salemi, G., et al. (2019). Cathodal Occipital tDCS Is Unable to Modulate the Sound Induced Flash Illusion in Migraine. Front. Hum. Neurosci. 13, 1â€“5. doi:10.3389/fnhum.2019.00247. Ognibene, D., and Giglia, G. (2015). Use of hierarchical Bayesian framework in MTS studies to model different causes and novel possible forms of acquired MTS. Cogn. Neurosci. 6, 144â€“145. doi:10.1080/17588928.2015.1057487.

Prestimulus alpha frequency and amplitude predict the generation of P1 latency and P3 evoked response amplitude

Jelena Trajkovic, F. Di Gregorio, G. Thut, V. Romei

Abstract

Aims. Alpha oscillatory activity (8-12Hz) represents an important fingerprint of cognitive and perceptual performance. Specifically, we recently offered a first causal evidence of a functional double-dissociation between different oscillatory parameters, linking alpha-frequency to the regulation of sensory evidence accumulation, and alpha-amplitude to their subjective interpretation. These findings highlight a functional overlap between oscillatory activity and event-related potentials (ERPs), where earlier components relate to perceptual elaboration and later ones to decision-making processes. These research streams have remained largely orthogonal, thus failing to show whether and how oscillations may shape subsequent ERPs. Therefore, the aim of the current study was to causally test the oscillatory model of ERPs genesis, where we hypothesize that pre-stimulus alpha frequency shapes early P1 component, and alpha-amplitude influences later P3 response. Materials and Methods. First, the hypothesized relationship was investigated by means of EEG recordings during a perceptual task, where measures of perceptual accuracy and subjective judgments were collected. Second, the hypothesized association was causally probed by means

of online rhythmic Transcranial Magnetic Stimulation (rTMS) in three groups of participants: 1) by occipital entrainment at the individual alpha frequency (IAF); 2) slowing-down IAF by 1Hz; 3) speeding-up IAF by 1Hz. Results. A significant negative relationship was found between IAF and P1 latency, with faster pre-stimulus IAF being related to shorter P1 latencies. At the same time, shorter P1 latencies were associated with higher task accuracy. Crucially, slowing-down IAF significantly delayed P1 latencies in the (same) right hemisphere, while speeding-up IAF significantly anticipated the same P1 component. On the other hand, a negative relationship was found between alpha- and P3 amplitude, whereas low alpha-amplitude trials were accompanied by higher P3 response. At the same time, higher P3 amplitude led to lower confidence ratings. Finally, induced higher pre-stimulus alpha-amplitude lowered P3 component. Discussion. Our results suggest relevant implications for the functional meaning of oscillatory properties for sensory and decision-making processes and how they impact the ERP genesis. Specifically, we demonstrate that IAF and alpha-amplitude represent flexible mechanisms that undergo adaptive changes under specific task demands, and directly and selectively shape the subsequent lower and higher-order evoked responses. Conclusions. By establishing a causal dissociation of IAF in shaping P1 evoked response latency, and alpha amplitude in shaping P3 response, the current research provides fundamental evidence in favor of the â€œoscillatory modelâ€•, shedding new lights on the relationship between prestimulus oscillations and the genesis and functional significance of evoked components. References: Palva, S., & Palva, J. M. (2007). New vistas for Î±-frequency band oscillations. Trends in neurosciences, 30(4), 150-158. Trends Neurosci. 30, 150â€“158 (2007). Di Gregorio F.*, Trajkovic J.*, Roperti C., Marcantoni E., Di Luzio P., Avenanti A., Thut G.,& Romei V. (2021) Tuning alpha rhythms to shape conscious visual perception. Nature Human Behavior (under review). Luck, S. J. (2014). An introduction to the event-related potential technique. MIT press.

The role of cognitive inhibition in the autonomic responses to pain induction: an empirical study

Giovanna Troisi, M. Casagrande, F. Favieri, G. Forte

Abstract

Several findings underline a relationship between pain sensitivity and cognitive functions. Moreover, heart rate variability (HRV) is considered a reliable index of autonomic activity associated with both pain experience and executive functioning. Regardless of this evidence, there is a lack of studies that adopt the HRV to assess physiological changes in the relationship between pain and cognition. This study aims to investigate the role of cognitive inhibition in the autonomic responses to pain induction. A population of 76 healthy adults (47 females and 29 males; age, mean = 23.17, sd = 10.76) completed the experimental procedure. The Stroop Task and the Go-NoGo Task were administered to assess cognitive inhibition in a randomized order; the Cold Pressure Arm Wrap was adopted to induce cold pain; HRV was recorded during rest (5 minutes before the cognitive tasks) and reactivity phases; HRV was analyzed in the frequency domain (LF-HRV, HF-HRV, and LF/HF ratio). After pain assessment, participants filled in the PANAS. The results revealed: a) a positive correlation between pain measures (thresholds and tolerance) and cognitive inhibition; b) performance in the Stroop Task, but not in the Go-NoGo Task predicted pain tolerance; c) cognitive inhibition mediated the statistic difference between LF-HRV recorded at baseline and during painful stimulation. These findings suggest that individuals with higher cognitive inhibition are more likely to manage pain successfully, and this ability is sustained by an autonomic control over the environmental stressors. The relationship between pain tolerance and the performance in the Stroop Task, but not in Go-NoGo Task, is probably due to the different processes involved in the two cognitive tasks: probably, pain tolerance involves processes and neural structures underling the inhibition of a dominant and automatic response, such as reading. Further studies, including a growing number of participants and other methods of pain induction, could be conducted to assess the relationship highlighted in this work better. References: Forte, G., Favieri, F., Casagrande, M. (2019). Heart rate variability and cognitive functions: a Systematic review. Frontiers in Neuroscience, 13, 1-11. Benarroch, E. E. (2006). Pain-autonomic interactions. Neurological Science, 27, 130-133. Koenig, J., Jarczok, M. N., Ellis, R. J., Hillecke, T. K., Thayler, J. F. (2014).

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Plasticity induction in visuo-motor chains through state-dependent cortico-cortical paired associative stimulation (ccPAS) over premotor-motor networks

Sonia Turrini, F. Fiori, V. Romei, A. Avenanti

Abstract

Goals: Neural pathways from the ventral premotor cortex (PMv) to the primary motor cortex (M1) allow for sensorimotor transformations. Yet, whether brain stimulation over the PMv-to-M1 pathway can target and transiently enhance or hinder specific visuo-motor associations remains to be determined. Here we sought to address this issue by using cortico-cortical paired associative stimulation (ccPAS), a novel TMS protocol able to modulate cortical connectivity between two stimulated sites through the mechanism of spike-timing-dependent-plasticity (1). Specifically, to target selected visuo-motor associations, we used a novel function-tuning ccPAS protocol (2) over the PMv-M1 network and test its effect on motor physiology. Materials and methods: To test the potential functional specificity of function-tuning ccPAS, we applied the protocol in state-dependent manner (2,3): ccPAS was administered over the PMv-M1 circuit during a simple action selection task engaging premotor-motor connections (index or little finger abduction in response to a target or control visual stimulus). ccPAS pulses were administered only during the execution of the target visuomotor associations (i.e., while participants moved a target finger associated with the presentation of a target visual stimulus); this way it is possible to maximally engage and enhance the functionally specific circuits (2) already pre-activated and tuned to the task at hand. We assessed corticospinal excitability (CSE) before and after ccPAS, while participants remained at rest and passively viewed the same target/control stimuli shown during ccPAS. Participants underwent, on different days, PMv-to-M1 and M1-to-PMv ccPAS, to test the effects of supporting or contrasting the physiological activation of visuo-to-motor premotor-motor connections. Results: We found that PMv-to-M1 ccPAS significantly increased CSE response to target visual stimuli, leaving CSE response to control stimuli unaltered. Conversely, M1-to-PMv ccPAS effectively reduced CSE irrespective of the visual input. Discussion: Our findings indicate a selective enhancement of visuomotor associations targeted during function-tuning PMv-to-M1 ccPAS and their inhibition following the reverse protocol (M1-to-PMv ccPAS). Our results shed important light on the functional properties of the PMv-M1 network, highlighting the malleability of spatially overlapping but functionally specific visuo-motor pathways. They also suggest that directional function-tuning ccPAS provides a tool for targeting and transiently modulating such circuits. Conclusion: The present study expands previous TMS evidence of state-dependency (3), by showing that function-tuning ccPAS can reach a noteworthy level of functional specificity over the cortical motor system. We conclude that function-tuning ccPAS allows the investigation of associative plasticity with functional precision, an advancement that can ameliorate our mechanistic understanding of visuomotor learning. References: Buch, E. R., Johnen, V. M., Nelissen, N., Oâ€™Shea, J. & Rushworth, M. F. S. Noninvasive associative plasticity induction in a corticocortical pathway of the human brain. J. Neurosci. 31, 17669â€“17679 (2011). Chiappini, E., Avenanti, A., Romei, V., Silvanto, J. & Hibbard, P. Strengthening functionally specific neural pathways with transcranial brain stimulation. Curr. Biol. 28, (2018). Silvanto, J., Cattaneo, Z. Common framework for â€˜virtual lesionâ€™ and state-dependent TMS: The facilitatory/suppressive range model of online TMS effects on behavior. Brain Cogn. 119, 32â€“38 (2017).

Changes in interoception and well-being during the quarantine for the Covid-19 pandemic

Alisha Vabba, G. Porciello, A. Monti, M. Panasiti

Abstract

OBJECTIVES: Interoception refers to the processing of the internal state of the body. Deficits in interoceptive processing caused by stressful events have been associated with altered psychological states,

such as depression, anxiety, and sleep disturbances. Given the important role of interoception in determining well-being and considering the relevance of focusing on visceral signals in order to check for symptoms of COVID-19 infection (e.g., breathing or body temperature) we ran a longitudinal study in which we tested if interoception and well-being changed before and during different stages of the pandemic and if and to which extent the former influenced the latter. MATERIALS AND METHODS: 245 Italian participants who had completed the Multidimensional Assessment of Interoceptive Awareness (MAIA) prior to the onset of the pandemic, repeated the questionnaire during the first quarantine in Italy (11th March - 3rd May 2020), and three months after the restrictions (1st -30th September 2020). They also completed survey measures of depression (PHQ-9), anxiety (STAI), and sleep disturbance (PSQI). A sub-sample of 28 participants, who had completed the heartbeat counting task (HCT) and a measure of heart rate variability (HRV) before the pandemic, was also tested remotely during the pandemic using two mobile applications (Cardiograph and HRV CAMERA). RESULTS: We found that while performance in the HCT (interoceptive accuracy) remained unvaried, MAIA scores (interoceptive sensibility) consistently increased from before the pandemic to the quarantine and remained unvaried three months after. HRV decreased significantly following the onset of the pandemic and remained unvaried three months later. Depression, anxiety, and sleep deprivation scores were higher during the quarantine with respect to three months after. Interestingly, we also found that well-being during the pandemic was negatively predicted by pre-pandemic level of specific components of interoceptive sensibility (e.g., the ability to regulate distress by attention to body sensations and the experience of oneâ€™s body as safe and trustworthy). DISCUSSION AND CONCLUSIONS: Our findings suggest that while interoceptive accuracy is a stable ability, the onset of the COVID-19 pandemic is associated to an increased attention towards visceral signals and to a general decrease in well-being measured subjectively (questionnaires) and objectively (HRV). Moreover, we found that specific pre-pandemic components of interoceptive sensibility predicted participants' levels of depression, anxiety, and sleep disturbance during the pandemic. These results highlight the role of interoception in contributing to well-being and protecting against stressful events and can ultimately provide novel insights for promoting and maintaining well-being.

ERP indicators of Self-Pain and Other-Pain Reductions to Placebo Analgesia Responding: The Moderating Role of the Fight-Flight-Freeze System

Arianna Vecchio, V. De Pascalis

Abstract

Background: This study evaluates the modulation of phasic pain and empathy for pain, induced by placebo analgesic effect during pain and empathy for pain tasks. Because pain can be conceptualized as a dangerous stimulus that generates avoidance, we evaluated how personality traits of approach and avoidance, as measured by the revised Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ, Corr and Cooper, 2016), modulate pain and empathy for pain responses. Methods: Sixty-three right-handed university student volunteers (32 women, range 18â€“29 years) were included. Subjective self-report ratings (self-pain and self-unpleasantness) and empathy for pain ratings (other-pain and other-unpleasantness) were collected while participants underwent painful electrical stimulation or witnessed that another person was undergoing such stimulation. We induced placebo analgesia, a phenomenon specifically modulating the first-hand experience of pain, to test whether this also reduces other pain. Amplitude measures of the N1, P2, and P3 components of the ERPs, elicited by electric stimulations, were obtained during a painful control as well as during a placebo treatment expected to induce placebo analgesia. Results and Discussion: Our findings indicate that placebo treatment induced a reduction of self-pain and self-unpleasantness, whereas during the empathy condition only reduction in otherunpleasantness was observed. For the N1 wave, we observed that placebo treatment induced a small but significant, reduction of N1 amplitude at midline centroparietal scalp regions in state anxiety reducers during the self-pain condition. In the empathy for a pain condition, placebo treatment also produced a relative N1 amplitude reduction in other pain reducers. Additionally, in the self-pain condition, placebo

treatment induced an amplitude reduction of the P2, and P3 waves in state anxiety reducers, and in participants reducing both pain ratings and state anxiety, or both unpleasantness ratings and state anxiety. Further, in the empathy pain condition, women exhibited higher P3 amplitudes than men during placebo treatment. Two separate conditional process analyses yielded that FFFS scores and the P2 and P3 amplitude reductions at the right centrotemporal region significantly influenced self-pain reduction. The moderator effects of FFFS in the relations linking P2 and P3 amplitude changes with pain reduction were both significant among low to moderate FFFS values. Conclusion: These observations are in line with the idea that lower levels of FFFS (active avoidance) scores can predict placebo-induced pain reduction. Findings are in line with the r-RST conceptualization that phasic pain is an aversive stimulus activating the active avoidance behavior to bring back the system to homeostasis. References: Corr, P. J., & Cooper, A. J. (2016). The Reinforcement Sensitivity Theory of Personality Questionnaire (RST-PQ): Development and validation. Psychological assessment, 28(11), 1427.

Diverse approaches to action predictions: novel neurofunctional insights

Chiara Verga, M. Musco, G. Tomaseig, E. Paulesu, L. Sacheli

Abstract

Aims. The key feature for successfully acting and coordinating in a social environment is the ability to predict and anticipate other peopleâ€™s actions and outcomes. This ability is mainly driven by contextual and movement actions cues. Focusing on the latter aspect, we explored the neurophysiology of action prediction processes, based on postural information. Through an event-related functional magnetic resonance (fMRI) experiment, we characterized the neural processes recruited in the prediction of the conclusion of overlearned actions like grasping and pointing. We also examined whether the brain regions involved in our task, requiring to predict the conclusion of overlearned simple actions, overlap with those previously identified by studies of action prediction of complex everyday-life or sport actions1,2 as assessed by a formal meta-analysis. Materials and methods. 32 healthy participants (17 females, mean age =23.5 ï,± 1.9) were instructed to observe implied-motion pictures showing mid-flight grasping or pointing actions, towards a cube-shaped object. After the implied-motion picture, a mask appeared, followed by a final picture that correctly concluded the mid-fight action in only 50% of the cases. The participants were explicitly instructed to predict the end-postures, evaluating as correct or incorrect the final picture. A color-recognition task served as perceptually matched baseline. Results. Overall, the participants brain responses associated with generating predictions overlapped with those identified by the meta-analysis and comprised a wide bilateral network of cortical areas including dorsal frontal and posterior parietal areas, as well as occipito-temporal regions, included in the so-called Action Observation â€˜mirrorâ€™ Network3, and the pre-supplementary motor cortex. Moreover, a whole-brain regression analysis identified specific brain regions brain regions associated with the participantsâ€™ behavioral performance (inverse efficiency scores). In particular, better performance resulted in stronger occipital activations, whereas worse performance in stronger activation of the right inferior frontal gyrus. These univariate results were further confirmed by a median-split multivariate pattern analysis conducted on the activation patterns obtained during action observation, which correctly classified (balanced accuracy = 84%, $p < .001$) participants based on their behavioral performance (good vs. bad â€˜predictorsâ€™). Discussion and Conclusion. These results suggested that the brain regions responsible for motor predictions during the observation of both complex and simple actions overlap and involve the same action-observation â€˜predictiveâ€™ network. Moreover, we show interindividual differences in action prediction strategies, suggesting a performance advantage associated with a more visually-based strategy, involving occipital areas, compared to a prefrontal strategy, which indicates a more cognitive-demanding approach. References: Smith, D. M. (2016). Neurophysiology of action anticipation in athletes: A systematic review. Neuroscience & Biobehavioral Reviews, 60, 115-120. Stadler, W., Schubotz, R. I., von Cramon, D. Y., Springer, A., Graf, M., & Prinz, W. (2011). Predicting and memorizing observed action: differential premotor cortex involvement. Human brain mapping, 32(5), 677-

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Neurophysiological and Cognitive Basis of the Self-Mirroring Technique: explicit and implicit measures of seeing own vs. others emotional expressions

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Abstract

The difficulty in accessing and recognizing own and others' emotions is a core problem shared by different psychiatric and psychological diseases, with a clinically significant impact on the patients' symptoms, psychotherapeutic process, and compliance to treatments. Therefore, improving emotional awareness is a central goal of psychotherapy, regardless of the specific orientation. Considering the importance of this objective, Vinai and colleagues developed the Self-Mirroring Technique (SMT), a video-based methodology consisting of showing patients a video of their face recorded during the recalling of an emotionally salient event and discussing with them the experienced emotion. Despite the effectiveness of SMT in psychotherapy, its neurophysiological underpinnings have not been investigated so far, as well as the possible dissociation between recognizing own and others' emotions. With this twofold aim in mind, we recruited eighteen healthy participants (15 females). We presented them with short video clips previously recorded (3 seconds each) depicting their own vs. other unknown faces expressing anger, happiness, sadness, disgust, fear, or a neutral emotion. We collected implicit (muscular) and explicit (ratings) measures. Electromyographic (EMG) activity was recorded during video presentation from three facial muscles, namely the zygomaticus major (ZM), the corrugator supercilii (CS), and the levator labii superioris (LLS). Emotion recognition, valence, and arousal ratings were collected after each trial. Linear mixed-effects models were used as a statistical procedure, including emotions, self/other expressions, and their interaction as fixed effects. Results suggested that participants were less accurate in recognizing their own vs. others' neutral expressions and rated fearful, disgusted, and neutral expressions as more arousing in the self than in the other condition. Facial EMG evidenced different activation patterns for self vs. other facial expressions, with lower CS activity for self than others' expressions while processing happy, sad, fearful, or neutral expressions. ZM activity was higher in self vs. others condition for anger and disgust. Finally, LLS activity increased during own sad and scared expressions and for others' happy and neutral stimuli. The complex pattern of our results suggests a dissociation between self and others' emotion processing affecting both implicit and explicit levels that will be discussed considering the facial mimicry theories.

Attention modulates Functional Connectivity in Prospective Memory: Insights from a MEG study

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Abstract

Prospective Memory (PM) is the ability to perform an intended action in the future, at the occurrence of a specific condition. The execution of a PM task requires to simultaneously allocate attention to inner states (to maintain intentions in memory) and to the environment (to detect the trigger for said intentions, the PM cue). In this study, we aim to investigate neurophysiological bases of PM by extracting Functional Connectivity metrics from Magnetoencephalography (MEG) data. 21 healthy young participants (M=24.67) performed a paradigm composed of three different conditions: The Baseline condition consisted in a simple ongoing task (LDT), the Intention-load in the same task presented together with prospective instructions that enhanced internal attention (subjects had to maintain multiple intentions in memory), whereas in the Monitoring-load block PM instructions enhanced external attention (the PM cue was harder to detect, increasing outward-directed monitoring). Neural signal was collected with a 275-channel CTF-MEG and reconstructed on individual MRI data. For each block, two Amplitude Envelope Correlation (AEC) matrices

were extracted from the signal (pre- and post-stimulus time windows, length: 500 ms), plotted on 148 brain subregions (Destrieux Atlas) and classified using the Yeo networks. The obtained matrices were compared between blocks, separately for the Theta and Alpha frequency bands. Theta: the Intention block showed increased connectivity within Default Mode Network (DMN) regions after the presentation of the stimulus, and stronger connections between bilateral anterior Cingulate Cortices and regions of the Dorsal Attention Network. The Monitoring condition showed increased within-network connectivity before the presentation of the stimulus, mostly within DMN and Frontoparietal Network regions. Alpha: before the presentation of the stimulus, the Monitoring block showed increased between-network connectivity, among Dorsal Attention, DMN and Ventral Attention Network region. In the Intention block, connectivity varied strongly within DMN regions, as the left subparietal sulcus correlated positively with right frontal areas and negatively with left frontal ones. Results show significant differences between PM tasks, as connectivity in Theta increased in the Monitoring condition before the appearance of the stimulus (reflecting the preparation for the detection of less salient PM cues), whereas in the Intention block it increased after the stimulus was presented (reflecting the retrieval of the appropriate intention). In the Alpha band, the increased pre-stimulus connectivity in the Monitoring block between regions of the DMN, and between multiple networks in the Intention condition can be interpreted as a lower involvement of those regions in each task. References: McDaniel, M. A., Umanath, S., Einstein, G. O., & Waldum, E. R. (2015). Dual pathways to prospective remembering. Frontiers in Human Neuroscience, 9. Cona, G., Chiossi, F., Di Tomasso, S., Pellegrino, G., Piccione, F., Bisiacchi, P., & Arcara, G. (2020). Theta and alpha oscillations as signatures of internal and external attention to delayed intentions: A magnetoencephalography (MEG) study. NeuroImage, 205, 116295. Soto, J. L. P., & Jerbi, K. (2018). Estimation of task-based modulations in functional connectivity with MEG: a comparison of methods. bioRxiv, 407213.