



# CNEF 2017

Proceedings of the International Conference  
**Cognitive Neuroscience  
of Executive Functions**

28<sup>th</sup> - 30<sup>th</sup> September 2017  
Padova - ITALY

ABSTRACT BOOK

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## Preface

These Proceedings gather the abstracts of talks and posters presented at the *Cognitive Neuroscience of Executive Functions 2017 Conference (CNEF\_2017)*, organized under the auspices of the Department of Neuroscience, Department of General Psychology, Padua Neuroscience Center, School of Medicine at the University of Padova. The conference was mainly held at the University Hospital of Padova and the Padova Botanic Gardens on the 28<sup>th</sup>-30<sup>th</sup> of September 2017. Each abstract published in the present Proceedings had been assessed by anonymous expert reviewers and by some of the organizers.

The inspiring occasion for organizing the CNEF\_2017 conference was the looming closure of an European Research Council Starting Grant Project: Life Experience Modulation of Executive Function Asymmetries; however, as soon as it was conceived, the event got bigger and bigger and ended up involving about 200 participants from all over the world, all attracted by a common interest in the cognitive and neural underpinning of executive functioning.

In particular, the CNEF\_2017 covered various aspects of executive functions, including their anatomo-functional organization in the human brain, how they are impaired by brain lesions and boosted through stimulation, training and experience.

The conference featured a full set of scientific events (see the Scientific Program in Part 1), such as a Round Table and 4 Symposia with renowned international speakers (Part 2), 7 brief talks from the LEX-MEA project (Part 3), and 2 Poster Sessions (Parts 4 & 5).

We thank all the authors who submitted an abstract to be included in these Proceedings and all the participants to the conference, who contributed to make this a highly valuable and enjoyable scientific event.

Last but not least, we especially acknowledge the European Research Council (LEX-MEA; GA# 313692), for covering the expenses of the invited speakers and all the sponsors of the CNEF\_2017.

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PART 1  
**Scientific Program CNEF 2017**

**28 Sept 2017**

*3 – 4.30 pm, Aula Morgagni, University Hospital Padova, via Giustiniani 2, Padova*

**Round-Table: Splitters and Lumpers in the Cognitive Neuroscience history**

*Chair* Carlo A. Umiltà

*3.00 – 3.30 pm. The splitters' point of view, Tim Shallice*

*3.30 – 4.00 pm. The lumpers' point of view, Maurizio Corbetta*

*4.00 – 4.10 pm. Discussant: Carlo Semenza*

**29 Sept 2017**

*Auditorium – Botanic Gardens, Padova*

*8.30 am – 9.30 am. Registration*

*9.30 – 9.45 am. Welcome Speech, A. Vallesi*

*9.45 am – 12.45 pm*

**Symposium: “Anatomo-functional models of Executive Control”**

*Chair: Tim Shallice*

*9.45 – 10.20 am. Where is the “top” in top-down executive control?  
Mark D’Esposito*

*10.20 – 10.55 am. Inhibitory Control as a Critical Component of  
Executive Function? Conceptual Formulations and Neurobiologi-  
cal Mechanisms. Marie Banich*

*10.55 – 11.20 am. **Coffee Break** (Foyer)*

11.20 am – 11.55 pm. Motivation and Cognitive Control. *Todd Braver*

11.55 am – 12.30 pm. Compositional cognition: learning a model of the world from its parts. *Christopher Summerfield*

12.30 – 12.45 pm. *General Discussion*

12.45 – 2.45 pm. **Light Lunch** and **Poster Session A** (Foyer)

2.45– 4.00 pm

**Mini-Session: “Oscillatory brain activity and Event-related potentials as a window to understand Executive Functions”**

Chair: Antonino Vallesi

2.45 – 3.15 pm. Slow Frontal-Midline Oscillations as a Gear-Box in the Brain. *Paul Sauseng*

3.15 – 3.45 pm. Bayesian brain: A computational approach to executive functions? ERP evidence. *Bruno Kopp*

3.45 – 4.00 pm. Asymmetric brain activity as a tool to predict executive functioning. *Antonino Vallesi (LEX-MEA project)*

4.00 – 4.30 pm. **Break & short visit to the Botanic Gardens**

4.30 – 5.30 pm

**Reports from team members of the LEX-MEA ERC project**

The hemispheric organization of executive functions in the brain: evidence from task-switching and monitoring tasks. *Mariagrazia Capizzi*

Electrophysiological correlates of proactive and reactive monitoring processes. *Ettore Ambrosini*

Sustained and transient neural correlates of cognitive control. *Vincenza Tarantino*

**30 Sept 2017**

*Auditorium – Botanic Gardens, Padova*

*8.30 am – 9.30 am Registration*

*9.30 am – 12.30 pm*

**Symposium: Boosting executive functions with experience, training and stimulation**

Chair: Maurizio Corbetta

*9.30 – 10.05 am. Learning to Learn: Lessons from Action Video Game Play. Dafne Bavelier*

*10.05 – 10.40 am. Short- and long-term plasticity of metacontrol. Bernhard Hommel*

*10.40 – 11.05 am. **Coffee Break** (Foyer)*

*11.05 am – 11.40 pm. Food for thoughts: how amino acids can enhance cognition. Lorenza Colzato*

*11.40 am – 12.15 pm. Enhancing executive functions: from neuro-imaging to brain stimulation. Emiliano Santarnecchi*

*12.15 – 12.30 pm. General Discussion*

*12:30 – 2:30 pm. **Light Lunch and Poster Session B** (Foyer)*

*2.30 – 3.45 pm*

**Mini-Session: Neuropsychology of executive functions**

Chair: Carlo Semenza

*2.30 – 3.00 pm, From anatomy, theory, experimentation, clinical diagnosis to a revised model of frontal lobe functioning: the story behind the story. Donald Stuss*

*3.00 – 3.30 pm, The lateralisation of subsystems of the Supervisory System. Tim Shallice*

3.30 – 3.45 pm, Assessment of frontal-executive abilities: Influence of age, aetiology and cognitive reserve. *Sarah MacPherson*

3.45 – 4.15 pm. **Break**

4.15 – 5.30 pm

**Reports from team members of the LEX-MEA ERC project**

Neural representations of model updating of temporal expectations: an fMRI study. *Antonino Visalli*

Decoding rule search domain in the left inferior frontal gyrus. *Michele Furlan*

Simultaneous interpretation as a model of expertise and training. *Laura Babcock*

Surgery in restricted prefrontal areas underlies general cognitive decline in brain tumor patients. *Sandra Arbula*

5.30 – 5.45 pm. *Best posters awards & Closing remarks*

## PART 2

### Invited Speakers – Abstracts

#### Round Table, 28 Sept 2017

**Participants:** Maurizio Corbetta, Tim Shallice, Carlo Semenza, Carlo Umiltà, Antonino Vallesi

**Title:** Splitters and Lumpers in the Cognitive Neuroscience history

**Abstract:** For many decades neuropsychologists and cognitive neuroscientists have intensively investigated functional and anatomical dissociations among different cognitive processes in healthy individuals and patients with focal brain damage. This enterprise has the goal to advance our understanding of human cognitive architecture. In recent years, a new approach has started to emerge which emphasizes anatomico-functional connectivity in cohesive brain networks. This approach seeks for minimal common factors that may account for maximum inter-individual variance in neurocognitive profiles. During this round-table, both approaches shall be first presented and then compared in order to try to understand whether we are facing a new paradigmatic shift or it is possible to reconcile, at least partially, the assumptions and goals of these apparently opposite positions.

### **Abstracts of the invited speakers' talks (alphabetic order)**

**Speaker: Marie T. Banich**, Institute of Cognitive Science, Dept. of Psychology & Neuroscience, University of Colorado Boulder

**Title:** Inhibitory Control as a Critical Component of Executive Function? Conceptual Formulations and Neurobiological Mechanisms

**Abstract:** The ability to exert Inhibitory control to stop actions or thoughts is often considered to be a central component of Executive Function, which is more broadly defined as the ability to exert control over goal-directed behavior. In this talk, I will provide a conceptual framework and empirical evidence suggesting that “inhibitory” control is not a unitary concept but rather can be considered as resulting from a more fundamental aspect of executive function, that is the ability to actively maintain a task goal. Evidence from motor control, long-term memory retrieval, working memory and emotional regulation will be provided to support the idea that lateral prefrontal cortex is critically important for maintaining such task goals, and that it is through its interaction with other brain regions that “inhibition” occurs. Implications for inhibitory control deficits in clinical populations, such as those with attention-deficit hyperactivity disorder, will be discussed.

**Speaker: Dafne Bavelier**, Dept. of Psychology & Educational Science, University of Geneva

**Title:** Learning to Learn: Lessons from Action Video Game Play

**Abstract:** A vexing issue in the field of learning is that, while we understand how to promote superior performance through practice, the resulting behavioral enhancement rarely extends beyond the practiced task. Such learning specificity is a major limitation for effective interventions, whether educational or clinical ones. Here we will consider first how learning and generalization may be enhanced, through a mechanism we term ‘learning to learn’ (L2L). We then ask what may be the determinants of ‘learning to learn’ – differentiating between adjusting parameters as learning of a specific task proceeds from extracting the structure across tasks to facilitate learning and generalization.

**Speaker: Todd Braver**, Washington University, St. Louis, US

**Title:** Motivation and Cognitive Control

**Abstract:** Research in my lab investigates the neural mechanisms that give rise to successful cognitive control: the ability to regulate thoughts and actions in an intelligent, goal-directed manner. We have argued that such mechanisms, which involve a network of brain regions centered on the lateral prefrontal cortex, can operate in either a proactive (i.e., anticipatory / sustained) or reactive (i.e., transient and stimulus-triggered) mode. This framework thus emphasizes the importance of examining temporal dynamics in the neural mechanisms of cognitive control. I will discuss recent studies focusing on the interaction of motivation and cognitive control. These studies will focus on: a) the productive utility of motivationally focused cognitive control studies; b) motivationally based distinctions between proactive and reactive control; and c) a theoretical perspective that treats cognitive control engagement as an economic decision-making process.

**Speaker: Lorenza Colzato**, Leiden University & Ruhr University Bochum

**Title:** Food for thoughts: how amino acids can enhance cognition

**Abstract:** There is growing research interest in evaluating the neuromodulatory effects of exogenous administration of neurotransmitter precursors on cognition. Upon administration, precursors are assumed to be converted into their end-products, thus increasing neurotransmitter levels and consequently, enhancing cognitive function. In this talk I will show how L-Tyrosine (TYR), amino acid precursor of dopamine, has been demonstrated to enhance facets of cognitive control in situations with high cognitive demands.

**Speaker: Mark D'Esposito**, University of California, Berkeley, US

**Title:** Where is the “top” in top-down executive control?

**Abstract:** Executive function is mediated by an interaction of top-down and bottom-up processes. Bottom-up processes are those that

guide automatic behavior and are determined by the nature of sensory input whereas top-down processes are determined by internal states such as knowledge from previous experience, intentions and goals. Although numerous theoretical models implicate the lateral prefrontal cortex (LPFC) as a source of top-down executive control signals, mechanistic insight regarding these signals remain underspecified. In this talk, I will present direct evidence that the LPFC is a source of top-down signals and that these signals are organized hierarchically whereby progressively rostral areas of the LPFC process/represent increasingly abstract information. Also, contrary to the dominant assumptions of this model of PFC organization, I will present new evidence suggesting that the mid LPFC, and not rostral LPFC is at the apex of the frontal hierarchy. This suggests that the mid LPFC serves as the “top” in top-down control, serving as a nexus for integrating information during executive control operations.

**Speaker:** Bernhard Hommel (Leiden University, Cognitive Psychology Unit & Leiden Institute for Brain and Cognition)

**Title:** Short- and long-term plasticity of metacontrol

**Abstract:** Functional and neuroscientific arguments suggest that human cognition and action is controlled by seeking a task- and context-sensitive state of balance between cognitive persistence (e.g., keep going for the present goal) and flexibility (being open for goal changes), which is likely to involve interactions between dopaminergic prefrontal persistence systems and striatal flexibility systems. I will discuss key factors that control these interactions (i.e., metacontrol): Short-term factors including meditation and neurofeedback, and long-term factors including genetic predisposition, religious upbringing, and culture.



**Speaker:** Bruno Kopp, Hannover Medical School, Germany

**Title:** Bayesian brain: A computational approach to executive functions? ERP evidence

**Abstract:** Executive functions are traditionally conceptualized as a set of abilities required to guide behavior toward goals. We develop a theoretical framework for executive function, which has its roots in the notion of hierarchical models that are maintained to predict activity at lower levels of the processing hierarchy (Kopp, 2012). Here, we examine event-related potential (ERP) correlates of surprise such as the P300 wave in the context of the Bayesian brain hypothesis. This hypothesis posits simply that neural activities code and compute Bayesian probabilities. We introduce an urn-ball paradigm, and we relate (single-trial) ERPs to Bayesian inference. Various methods are utilized to compare Bayesian models in terms of their ability to explain variation in ERPs at different points in time and over different regions of the scalp in a series of studies (Kolossa et al, 2015; Kopp *et al.*, 2016; Seer *et al.*, 2016). Specifically, we are interested in dissociating specific ERPs in terms of Bayesian updating and predictive surprise. Bayesian updating refers to changes in a model's probability distributions given new observations, while predictive surprise equals the surprise about new observations under these probability distributions. Our data suggest that distinct components of the P300 wave (P3a, P3b) provide dissociable measures of Bayesian updating and predictive surprise. Specifically, the updating of beliefs about hidden states yields the best fit for the anteriorly distributed P3a, whereas parietally distributed P3b responses are best fit by predictive surprise. These results indicate that P3a and P3b components reflect distinct Bayesian computations. They are consistent with the Bayesian brain hypothesis, and they are amenable with hierarchical models of executive function. Viewed from a broader perspective, these data suggest that the hierarchical structure of executive control renders the human brain a pre-adaptive system, which possesses the ability to adapt to environmental events *before* they actually happen.

**Speaker: Sarah E. MacPherson,** Edinburgh University, UK

**Title:** Assessment of frontal-executive abilities: Influence of age, aetiology and cognitive reserve.

**Abstract:** Neuropsychological group studies are one of the main methods to examine the organisation of frontal-executive abilities. Such studies typically consider patients with lesions due to different aetiologies such as stroke or tumour as one group and few studies have compared the performance of these different types of patients on neuropsychological measures. Furthermore, it is widely known that the cognitive response to brain damage and/or age-related changes can significantly vary across individuals due to their premorbid efficiency, capacity and flexibility of cognitive processing. In this talk, I will discuss recent work that examines the influence of age, aetiology and the independent effects of two Cognitive Reserve (CR) proxies, education and NART IQ on measures of executive function as well as other neuropsychological tests in large groups of patients with focal, unilateral frontal or nonfrontal lesions. The findings suggest that the distinct protective effects of education and NART IQ are limited to specific cognitive measures and that age plays a role in frontal-executive performance in addition to the contribution of these CR proxies.

**Speaker: Emiliano Santarnecchi,** Berenson-Allen Center for Non-Invasive Brain Stimulation, Harvard Medical School, Boston, MA, USA.

**Title:** Enhancing executive functions: from neuroimaging to brain stimulation.

**Abstract:** Executive functions (EF) are the building blocks of human higher order cognition. While their psychometric properties have been widely characterized in the last two decades, their neuroanatomical, functional and electrophysiological underpinnings are still a matter of debate, posing a limit to the efficacy of cognitive enhancement interventions. Here we will explore the anatomical overlap between inhibition, switching and updating, their relationship with well-known resting-state fMRI networks, as well as their functional overlap with other functions within the convergent and divergent thinking

domains. Potential scenarios for enhancement of executive functions via cognitive training and non-invasive brain stimulation will be also discussed, leveraging the data of the SHARP study (“Strengthen Human Adaptive Reasoning and Problem Solving”, funded by the United States Director of National Intelligence - IARPA), a multi-center effort at Harvard, Oxford, Northeastern university and Honeywell company, aimed at increasing fluid intelligence and executive functions via an individualized, adaptive executive functions training combined with transcranial electrical stimulation (tES, e.g. tDCS, tRNS, tACS). Results will be discussed focusing on the possibility to (i) increase performance with a two weeks EF training combined with tES, to (ii) generate transfer over other cognitive functions, as well as to (iii) select potential targets for brain stimulation based on neuroimaging data.

**Speaker:** Paul Sauseng, Department of Psychology, Ludwig-Maximilian-University Munich, Germany

**Title:** Slow Frontal-Midline Oscillations as a Gear-Box in the Brain

**Abstract:** Depending on which kind of information needs to be retained in working memory, and dependent on what exact mental transformation this information has to undergo, different working memory sub-processes will be necessary. These sub-processes are supposed to be implemented within different cortical networks. But how are these networks coordinated? How is communication in one reinforced and coupling of another one reduced depending on the task-requirements? Here I will provide a theoretical framework and empirical data arguing that slow brain oscillations in the prefrontal cortex – and specifically their phase to which fast frequency brain activity is locked - allow a simple and efficient mechanism by which fronto-parietal brain networks can be dynamically coupled or desynchronized, and hence, working memory processes can be coordinated. Electroencephalographic and combined EEG and non-invasive brain stimulation data from healthy participants, elderly volunteers and psychiatric patients will be presented.

**Speaker: Tim Shallice**, University College London and SISSA, Trieste

**Title:** The lateralisation of subsystems of the Supervisory System

**Abstract:** I will discuss a variety of active thought processes that lateralise within lateral prefrontal cortex, as far as one can judge from neuropsychological investigations, and in particular, neuropsychological group studies. These include, as far as left lateral prefrontal cortex is concerned: construction of the preverbal message, abstraction, manipulation within a well-defined problem space (Goel) and deduction. As far as the right prefrontal cortex is concerned, they include active monitoring and novel strategy production within an ill-defined problem space.

**Speaker: Christopher Summerfield**, Oxford University, UK

**Title:** Compositional cognition: learning a model of the world from its parts

**Abstract:** Humans can perform remarkably complex tasks, such as flying an aircraft or playing a violin concerto. The collection of mechanisms that underlie task-level performance (“executive functions”) and their neural implementation in the prefrontal cortex have been extensively investigated by psychologists and neuroscientists. However, we know remarkably little about how new tasks are learned. This is a pressing problem, because despite recent advances in machine learning, researchers are currently unable to build intelligent systems that learn to perform multiple complex tasks in series (e.g. successive Atari games) without resetting network parameters. My talk will focus on the challenges of understanding task learning in humans, and describe recent work that has suggested that complex tasks can be best solved when broken down into their constituent parts (compositional learning). I will illustrate with examples from tasks involving navigation, visual categorisation, and value-guided learning in novel environments.

**Speaker:** Donald Stuss, University of Toronto, Canada

**Title:** From anatomy, theory, experimentation, clinical diagnosis to a revised model of frontal lobe functioning: the story behind the story

**Abstract:** This presentation tracks the evolution of several factors important in understanding the brain-behaviour relations of the frontal lobes. The major factor was the influential theory of the Supervisory Attentional System; was it possible to decipher if there were independent components of this Supervisory System? The second factor was clarification about the process of neuroanatomical development; does knowledge of anatomy provide clues about functional brain organization? And how does one design an experiment to isolate specific frontal brain-behaviour relations? The third influential factor was experimental design. The frontal lobes were considered important when task demands were novel or complex, yet the use of novel or complex tasks resulted in impaired functioning after damage in many brain regions, not just frontal. What type of tasks should one use to identify if possible specific relationships between frontal regions and independent behaviours? The final factor related to the type of patients one needs to study to address the questions above. This is the story of how researchers combined expertise to lead to a revised model of frontal lobe functioning.

**Speaker:** Antonino Vallesi, University of Padova, Italy (LEX-MEA project)

**Title:** Asymmetric brain activity as a tool to predict executive functioning

**Abstract:** This talk will focus on electrophysiological and neuroimaging evidence for gradients of hemispheric asymmetries in executive functions. In particular the studies I will present point towards a left-lateralized, phasic criterion-setting and a right-lateralized, tonic monitoring process. Asymmetries relevant for executive functions have been observed not only in a task-related fashion, but also in

terms of resting-state activity. In particular, EEG measures of lateral frontal asymmetries have a predictive value as they account for the performance level on various executive function tasks. These findings are important as they validate, and extend to the healthy population, a model that was originally based on neuropsychological evidence.

PART 3  
**CNEF 2017 LEX-MEA project Abstracts**

**1. The hemispheric organization of executive functions in the brain: evidence from task-switching and monitoring tasks**

Mariagrazia Capizzi<sup>1</sup>, Ettore Ambrosini<sup>1</sup>, Sandra Arbula<sup>1</sup>, Ilaria Mazzonetto<sup>1,2</sup>, Antonino Vallesi<sup>1,3</sup>

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Keywords: Hemispheric lateralization, ERPs, Spatial domain, Verbal domain

Everyday behavior requires both the abilities to flexibly switch among different tasks and to continuously monitor our environment for the occurrence of relevant events. Previous studies have suggested that these two key executive functions are respectively mediated by left- and right-lateralized prefrontal brain areas. However, these results have been often confounded by the task domains employed such as verbal or spatial. Accordingly, it is unclear yet whether the supposed left and right hemispheric dominance associated with task-switching and monitoring is genuinely driven by their underlying (lateralized) processes or the domain of the tasks to be performed. To explore this issue, we designed a novel paradigm in which task-switching, monitoring and cognitive domains (spatial vs. verbal) were orthogonally manipulated in the same group of participants. The neural correlates of task-switching and monitoring were determined through event-related potentials (ERPs) and source reconstruction of the electrophysiological data. The ERP results showed that neither task-switching nor monitoring interacted with domain, thus suggesting the involvement of common domain-general mechanisms. Moreover, while task-switching elicited more transient ERPs localized to left prefrontal areas, monitoring was mainly associated with sustained ERPs generated by right-lateralized prefrontal regions. Overall, our findings extend previous research by supporting the fractionation of executive functions along the left-right axis of the prefrontal cortex.

## 2. Electrophysiological correlates of proactive and reactive monitoring processes

Ettore Ambrosini<sup>1</sup>, Antonino Vallesi<sup>1,2</sup>

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Keywords: Monitoring, Proactive cognitive control, ERP, ERSP

Monitoring represents a multifaceted executive function. It can be defined as a “quality control” process that checks the consequences of one’s actions or of the state of the environment against the task goals in order to strategically optimize behavior. According to some views, monitoring would mostly rely on right fronto-parietal circuits and be independent of the cognitive domain involved (e.g., verbal, spatial). However, a thorough description of its functional characteristics and related neural underpinnings is still missing. The present electroencephalography study used event-related potentials and spectral perturbations to investigate the electrophysiological correlates and functional differences between two types of monitoring processes, namely a reactive and a proactive one. A further aim was to confirm the domain-general nature and right hemispheric asymmetry of monitoring. Twenty-four participants performed a custom-devised tracking task in which the cognitive domain of the stimuli (verbal vs. spatial) and the predictability of target occurrence (regular vs. random) were orthogonally manipulated. Monitoring was expected to be recruited more extensively in the predictable trials, in which the conditional probability of target occurrence was manipulated. A number of electrophysiological effects were observed proactively before the target occurrence of the target in the regular conditions, including a right-lateralized frontal negativity, suggesting that proactive monitoring is mediated by distinct tonic, dynamic mechanisms. Importantly, cognitive domain did not interact with these effects. The present findings thus suggest a functional dissociation between proactive and reactive monitoring and confirm their domain-general nature and right-lateralization, thus further contributing to our understanding of monitoring processes.



### 3. Sustained and transient neural correlates of cognitive control

Vincenza Tarantino<sup>1</sup>, Ilaria Mazzonetto<sup>1,2</sup>, Antonino Vallesi<sup>1,3</sup>

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**Keywords:** Cognitive control, Task switching, Monitoring, EEG-fMRI

A series of experiments has been conducted to disambiguate the neural correlates of sustained and transient processes supporting cognitive control. To this aim, a cued switching task and an event monitoring task were examined. The analysis of event-related potentials (ERPs) in the cued switching task revealed the presence of distinct phasic and sustained brain responses in preparation to the upcoming target (i.e., during the cue-to-target interval). Specifically, the cue elicited sustained ERP deflections in mixed-task blocks compared to single-task blocks, whereas it elicited phasic ERP responses when switching to a new task (switching trials) compared to repeating a previous one (repeat trials). While the first ERP components were estimated to be generated by bilateral fronto-parietal areas, the second ones derived from the activity of left lateralized parietal areas. The event monitoring task was performed during the simultaneous recording of functional magnetic resonance and EEG. The coupling of the two techniques showed the sustained (i.e., across trials) involvement of a bilateral fronto-parietal network, and the transient intervention of right lateralized fronto-parietal clusters. Overall, the results suggest that the sustained components of cognitive control were common to different tasks and likely reflected the cooperation of bilateral fronto-parietal areas. On the other hand, the transient components reflect more lateralized brain areas, specific for the required type of control (i.e., switching vs. monitoring).

## 4. Neural representations of model updating of temporal expectations: an fMRI study

Antonino Visalli<sup>1</sup>, Mariagrazia Capizzi<sup>1</sup>, Ilaria Mazzonetto<sup>1,2</sup>, Antonino Vallesi<sup>1,3</sup>

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Keywords: Bayesian brain; Foreperiod; Hazard function; Temporal preparation; fMRI

It is well-established that we are able to predict *when* a relevant event might occur and to flexibly update prior temporal expectation weighting current evidence. Theoretically, these processes seem to obey to the Bayes' rule:  $P(A|B) \propto P(B|A)P(A)P(A|B) \propto P(B|A)P(A)$ . Several studies have demonstrated that humans make use of expectations about event timing in order to improve performance. However, a direct modeling of how the brain updates temporal expectation within a Bayesian framework is poorly explored. In the present study, we combined a temporal preparation task with the excellent spatial resolution of fMRI to address this issue. Participants were required to respond to the onset of a target that followed a neutral warning signal. The foreperiod between warning and target was drawn from a Gaussian distribution, whose mean and standard deviation were kept constant across the trials of a block but, critically, changed across different blocks. To quantify updating, we used a normative Bayesian learner to compute for each trial the posterior probability of target onset. Then, the trial-by-trial Kullback-Leibler divergence ( $D_{KL}$ ) between the posterior and the prior was used to model the fMRI data. The results showed that  $D_{KL}$  modulated a set of posterior and prefrontal regions, especially in the posterior parietal lobules and in the right dorsolateral prefrontal cortex. To conclude, the present study represents, to the best of our knowledge, the first attempt to provide a mathematical and neuroanatomical model of how the brain forms and adjusts expectations in the temporal preparation.

## 5. Decoding rule search domain in the left inferior frontal gyrus

Michele Furlan<sup>1</sup>, Laura Babcock<sup>2</sup>, Antonino Vallesi<sup>1,3</sup>

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**Keywords:** fMRI, Frontal Lobe, MVPA, Hemispheric specialization, inductive reasoning

Traditionally, the left hemisphere has been thought to extract mainly verbal patterns of information, but recent evidence has shown that the left Inferior Frontal Gyrus (IFG) is able to apply inductive reasoning to both verbal and spatial information. Here we used multivoxel pattern analysis to decode the representation of rule domain during different types of rule search. Thirteen participants were asked to extract the rule underlying streams of letters presented in different spatial locations. The rule was either verbal (letters forming words) or spatial (positions forming geometric figures). Moreover, the rule search was carried out either on a single pre-cued domain (i.e., the domain to attend was known by participants) or in parallel (i.e., the domain to attend was unknown). Our results show that information about rule domain is reliably represented in the left prefrontal cortex only, and that this representation was stronger when the domain to attend to was known in advance. These findings were confirmed in a subsequent replication with a parallel version of the experiment with the same participants, at least at the group level. This study extends our knowledge on the neural basis of goal-directed behaviors and on how information relevant for rule extraction is flexibly mapped in the prefrontal cortex.

## 6. Simultaneous interpretation as a model of expertise and training

Laura Babcock<sup>2</sup>, Sandra Arbula<sup>1</sup>, Mariagrazia Capizzi<sup>1</sup>, Antonino Vallesi<sup>1,3</sup>

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Keywords: Simultaneous interpretation (SI); Expertise; Training

A growing number of studies suggest that our life experiences have a measurable influence on our cognitive abilities. This is apparent both in investigations of experts in a particular field and in examinations of skill acquisition and training. We propose simultaneous interpretation (SI) as a model for both of these research areas. SI is a cognitively demanding process in which an individual must comprehend a stream of auditory material in one language and with a few seconds delay produce the same content in another language. To perform SI at a professional level, a considerable amount of skill is necessary, which is acquired through specific training. Our first study explored the cognitive profile associated with SI expertise by examining professional interpreters and multilinguals on executive functioning tasks. The interpreters showed advantages on tasks that measured processes recruited during SI; specifically, they showed larger verbal short-term and working memory spans and better sustained control of multiple sets. These results mirror those typically found for experts in other domains. A second study explored the role that training has in producing these interpreter benefits. Students earning a Master of Conference Interpreting and two control populations were examined longitudinally. The results revealed no advantage in executive among the interpretation students at the start of training. However, the longitudinal data revealed an SI training-specific advantage in verbal short-term memory. These results suggest that interpreter advantages are acquired, rather than pre-existing. Further, they highlight the value of SI training as an ecologically valid model of training.

## **7. General cognitive decline after left prefrontal tumor surgery: implications for prefrontal cortex organization**

Sandra Arbula<sup>1,#</sup>, Ettore Ambrosini<sup>1</sup>, Serena De Pellegrin<sup>1</sup>, Mariagiulia Anglani<sup>2</sup>, Luca Denaro<sup>1,c</sup>, Domenico D'Avella<sup>1,3</sup>, Alessandro Della Puppa<sup>4</sup>, Carlo Semenza<sup>1,5</sup>, Antonino Vallesi<sup>1,5</sup>

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**Keywords:** Brain tumor; Frontal lobe; Cognitive decline; Principal component analysis; Lesion-symptom mapping

Valuable information derived from neuropsychological studies resides in uncovering the critical role of the affected region for the ability under investigation. However, lesion research of prefrontal cortex (PFC) functions is often obstructed by the impurity of the tasks employed, which tap closely interrelated processes and rely on common information resulting from lower-level processes. This issue has made the integrative and fractionated views of PFC organization not easily dissociable within lesion-based research. In our study we approached this issue by exploring whether surgery-induced lesions in brain tumor patients cause stronger cognitive decline if performed in specific prefrontal areas, as suggested by the integrative view. A principal component analysis was applied on distinct neuropsychological test scores to obtain a purer measure of general cognitive functioning, which was then compared by means of lesion-symptom mapping analysis across different lesion locations and, additionally, across different tumor histological types. Confirming previous studies, surgery-induced cognitive decline was greatest in low-grade glioma patients. More critical for the present study, surgery in confined left dorsolateral frontal areas caused the greatest cognitive decline regardless of tumor histology. Findings from this study support the recently suggested integrated albeit modular view of brain functional organization, according to which specific brain regions are highly involved across different

sub-networks and subserve a vast range of cognitive abilities. Although our previous lesion studies brought evidence for functional specialization within left and right frontal areas, these results are not necessarily in contrast and might reflect complementary lesion repercussions on both integrative and functionally specialized processes.

PART 4  
**Abstracts: Poster Session A (29 Sept 2017)**

**A1. Short-term maintenance of visual information  
across unfilled and distractor-filled delays**

Jan Derrfuss<sup>1\*</sup>, Matthias Ekman<sup>2</sup>, Michael Hanke<sup>3</sup>, Marc Tittgemeyer<sup>4</sup>,  
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Keywords: Short-term memory, Working memory, Distractor resistance,  
Functional magnetic resonance imaging

The brain regions involved in the representation of distractor-resistant information in visual short-term memory (STM) have been a matter of debate. While early single-unit recordings in monkeys and fMRI studies in humans implicated prefrontal cortices, more recent studies highlighted the importance of posterior cortices for both maintenance of information in unfilled as well as distractor-filled delay phases. The present study used a delayed match-to-sample task with three extended delay phases and multivariate searchlight analyses of fMRI data to investigate which areas maintain information in STM. Participant were asked to encode two sample pictures (faces or houses) and to maintain these across an initial unfilled delay, a subsequent distractor-filled delay, and another unfilled delay. Results showed that it was possible to decode STM contents in all three delays. Regions with above-chance decoding were located in the occipital lobe, the temporal lobe and the posterior parietal lobe. In the ventral temporal lobe, including the fusiform face area and the parahippocampal place area, activity patterns were reinstated after distraction. In more posterior regions, activity pat-

terns were not reinstated, but were delay-specific. Classifier performance in all delay phases was correlated with the behavioral performance in house trials, but not face trials. The results suggest that distributed posterior, not prefrontal, cortices are involved in the active maintenance of sample information in unfilled and distractor-filled delays. The correlation with behavior suggests that active STM maintenance is particularly relevant in house trials, whereas face trials might rely to a higher degree on a long-term memory contribution.

## **A2. The influence of positive affect arousal, task difficulty and working memory capacity on proactive cognitive control**

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Keywords: Proactive cognitive control, Arousal positive affect, Task difficulty, Working memory capacity

Previous studies provided ambiguous results on the impact of affect arousal on cognitive control. This mainly concerns the role of positive affect arousal in the modification of the proactive control. In addition, previous studies used different research procedures or different modifications of the same procedure. Therefore, the aim of our study was to arrange the existing research results and to find the reason for their discrepancies. Our study involved 155 participants ( $M = 20.97$ ;  $SD = 1.51$ ) divided into six groups. Groups were subdivided on the basis of working memory capacity (WMC) (high vs low) and affect (neutral vs positive-high arousal vs positive-low arousal). Approach-motivated positive affect was controlled. We used an AX-CPT paradigm and images from the Nencki Affective Picture System. There were two levels of task difficulty (easy vs hard). We observed main effects of task difficulty, sequences (AX; AY; BX; BY) of the AX-CPT paradigm, the interaction between sequences and WMC, task difficulty and sequences and the second-order interaction between sequences, WMC and task difficulty.



No effect of positive affect was observed. However, in Proactive Index we showed interaction between task difficulty and affect. We observed a difference between easy and hard tasks in the low arousal positive affect condition. Furthermore we noticed marginally significant difference between neutral and low arousal condition in hard tasks. We showed the interactive influence of arousal, task difficulty and WMC on cognitive control. In addition, we have tried to explain the existing discrepancies in the previous studies. This study was supported by the National Science Center, Poland.

### **A3. The effects of arousal and approach-motivated positive affect on the proactive control. An ERP study**

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Keywords: Proactive control, Affect arousal, Approach-motivated affect, AX-CPT, P3b, CNV, P3a, N2

Previous studies show that affect is an important component that modifies the cognitive control. Results of the research conducted in the Dual Mechanism of Control framework indicate that positive affect modulates the proactive control. However, the relationship between the affect components (i.e. arousal, approach motivation) and proactive control is not fully understood. The aim of our study was to investigate the interaction of the proactive control and both arousal and approach-motivated positive affect. The study comprised 25 subjects (5 men;  $M = 21.32$  years,  $SD = 1.44$ ). They were selected based on their WM capacity. Participants' mood and internal motivation were also controlled. We used an AX-CPT paradigm, which elicits the proactive and reactive executive control. The procedure was adapted for the purpose of ERP recording. We manipulated the affect level using images from the Nencki Affective Picture System. ERPs were recorded with a 64-channel system. P3b and Contingent Negative Variation (CNV) components, which are considered the indicators of the proactive control and N2 and P3a for the reactive control were analyzed. Results showed that approach-motivated positive affect modifies the P3b and CNV amplitudes in A-cue and B-cue

sequence, but it does not change the N2 and P3a amplitudes. Interestingly, there was no main effect of arousal. We observed the interaction effect between arousal and approach-motivated positive affect. We showed that proactive control is modulated to the greater extent by the approach-motivated affect than by the level of affect arousal. This study was supported by the National Science Centre (Poland) grant No. UMO-2015/17/N/HS6/02770.

## **A4. No Effect of Fronto-Medial transcranial Direct Current Stimulation on Working Memory Processes**

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Keywords: Transcranial Direct Current Stimulation (tDCS), Working memory, Frontal midline theta

Cortical slow oscillations in the theta frequency range (4-8 Hz) in the medial prefrontal cortex have been associated with executive control of working memory processes. Moreover, this frontal midline theta activity can be transiently modulated by transcranial Direct Current Stimulation (tDCS) placing an electrode over a fronto-medial stimulation site (Fz) and the return electrode on the chin. The goal of this study was to investigate whether this stimulation montage also has an effect on working memory performance. It is predicted that tDCS with the anode over Fz (and cathode on the chin) should lead to a better performance compared to when the cathode is placed over Fz (and anode on the chin). To test this, 84 young adults performed a standard 2-back task before and after 10 min of 2 mA tDCS. Participants were divided in three groups in which either anodal, cathodal or sham stimulation was applied. Based on hit and false alarm rate, the difference in  $d'$  between the baseline and the post-tDCS block for each participant was calculated. No significant differences between the three groups in working memory performance were found. Thus, the tDCS montage with one electrode over a fronto-medial stimulation site and the return electrode on the chin had no effect on working memory performance. This was also replicated in smaller samples using different tasks. However, frequency-specific oscillatory elec-

tric stimulation using transcranial Alternating Current Stimulation (tACS) in the theta frequency range might be able to impact working memory performance with this fronto-medial stimulation montage.

## **A5. Working memory assessment: A study with verbal, visual, or spatial n-back tasks**

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Keywords: Working memory, n-back, Assessment

The aim of this study was to assess the influence of verbal, visual, or spatial stimuli on n-back performance. Participants are presented with a sequence of stimuli, and are required to press a designed key if the current stimulus matches the one from n- steps earlier presented in the sequence. The load factor is adjusted to make the task more or less difficult and includes 2-back and 3-back conditions. The working memory buffer needs to be updated continuously to keep track of what the current stimulus must be compared to. Two-hundred university students were tested. Half of the participants performed the 2-back condition, and half performed the 3-back condition. Each condition presented two verbal (letters or words), two visual (circles with different textures or meaningless images) and two spatial (configurations or matrices) n-back tasks. Each stimulus was presented at the center of the screen for a time interval of 2000 ms. ANOVAs carried out on accuracy and on correct RTs showed a less efficient performance when memory load increased and a task effect. The two visual n-back tasks were the most difficult tasks, whereas the word n-back task was the easier task. Factor analyses showed that a common working memory component explained accuracies and reaction times of the 2-back condition. For the 3-back condition the same single component explained reaction times, whereas an additional verbal component explained the accuracies. The n-back task is an appropriate tool for working memory assessment, even when stimuli required verbal, visual or spatial encoding.

## **A6. Feeling poorer temporarily impairs working memory**

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Keywords: Socioeconomic status, Working memory, Stereotype threat

The relative social and economic standing in relation to others, the socioeconomic status (SES), has been shown to influence executive functions in confrontational settings. In individuals with low SES, such influence is often found to be negative, resulting in a reduced performance on a range of cognitive tests requiring working memory and inhibition. These effects are often attributed to the consumption of executive resources due to the activation of negative stereotypes associated with having a low SES, a phenomenon known as stereotype threat. Nevertheless, no study so far tested whether the manipulation of how an individual perceives his/her own SES in relation to others would elicit similar effects. That is, whether being induced to feel poorer than someone else negatively affects cognitive performance. The present study explored this idea by testing the performance on an n-back task following the attribution of a low (vs. high) relative SES. Whereas the expected difference between the experimentally manipulated low- and high-SES groups in the overall performance was not statistically significant, a further exploration of the data revealed a significant difference in the trials immediately following the manipulation. The results are interpreted as an instance of stereotype threat stemming from the manipulation of relative SES, temporarily impairing working memory.

## A7. Fronto-Medial transcranial Alternating Current Stimulation during Working Memory

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Keywords: Transcranial alternating current stimulation (tACS), Frontal mid-line theta (FMT), Working memory

Rhythmical brain activity in the theta frequency range (4-8 Hz) over human medial prefrontal cortex has been associated with cognitive control processes, such as sustained attention or the maintenance and manipulation of information in working memory. Recently, it has been reported that this frontal midline theta activity (FM-theta) was transiently modulated by anodal transcranial Direct Current Stimulation (tDCS), with the stimulation electrode over a fronto-medial site (Fz) and the return electrode on the chin. Yet, this stimulation montage had no effect on performance in sustained attention or working memory tasks. Here we asked whether such a montage would increase performance when more selectively stimulating theta band oscillatory activity through frequency-specific electric stimulation, using transcranial Alternating Current Stimulation (tACS). In our pilot study, we targeted FM-theta by applying tACS over fronto-medial and chin positions at theta (6 Hz). 59 young adults participated in the study and performed a standard 2-back task before and during tACS. Participants were assigned to one of two groups which then received either real or sham stimulation. The difference in  $d'$  between the baseline and the stimulation block (delta  $d'$ ) showed a trend for a significant group difference. Delta  $d'$  was significantly different from zero in the real stimulation condition, but not so in the sham condition.

## **A8. Different load conditions in a working memory task: a fNIRS-EEG study to investigate the processes involved**

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Keywords: Working memory, fNIRS, EEG, N-back

Working memory (WM) is part of executive function, which allows the brain to store, manipulate and process information. Here, we combine different neurophysiological techniques to investigate further the involvement of the frontal lobes in WM. Twenty- three adults performed a visuo-spatial n-back task, formed by control condition (0-back), one with low (1-back) and one with high WM load (2-back). Behavioural and fNIRS-EEG data were recorded. Participants were slower in the 2-back ( $426 \pm 121$  ms) compared to both 1-back ( $334 \pm 58$  ms) and 0-back ( $328 \pm 52$  ms). P2 component (attention) at Fc1/Fc2 showed greater amplitude in the 2-back and 1-back conditions compared to 0-back; 2-back showed an earlier latency peak ( $300 \text{ ms} \pm 60$ ) than both 1 ( $384 \pm 108$  ms) and 0-back ( $369 \text{ ms} \pm 109$ ) conditions. P3 latency at Pz positively correlated with reaction time and the peak was found earlier in 2-back ( $408 \pm 72$  ms) than 1-back one ( $360 \pm 60$  ms). Left anterior superior prefrontal gyrus showed higher oxygenated and less deoxygenated haemoglobin in the 2-back (deoxygenated haemoglobin =  $.000242 \pm .000186$  mol/L; oxygenate haemoglobin =  $-.000509 \pm .000825$  mol/L) compared to 0-back (deoxygenated haemoglobin =  $-.000186 \pm .000318$  mol/L; oxygenate haemoglobin =  $.000194 \pm .00068$  mol/L) condition. Deoxygenated haemoglobin positively correlated with P3 latency at Pz in the 0-back condition. Our results showed an effect of WM requirements on fronto-central P2 amplitude and latency. Hemodynamic response on the left anterior superior prefrontal correlated with P3 latency only when the task is free from WM requirement (0-back). Our data suggest that during n-back task (1-back and 2-back) additional process are required, which slow down reaction times, reducing the overlap between stimulus categorization and response selection processing.

## **A9. Dorsolateral prefrontal cortex and cognitive control: new evidence from continuous theta burst stimulation**

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**Keywords:** Cognitive Control, Dorsolateral Prefrontal Cortex, Simon effect, Continuous Theta Burst Stimulation

Despite the involvement of dorsolateral prefrontal cortex (DLPFC) in cognitive control has been documented by several neuroimaging studies (see Cieslik *et al.*, 2013; Niendam *et al.*, 2012), its role in conflict processing mechanisms has been scarcely investigated using brain stimulation techniques (Olk *et al.*, 2015), the only ones that allow to establish causal relations between brain structure and function. For this reason, in the current study we tested the effect of continuous Theta Burst Stimulation (cTBS) over the DLPFC in the performance at a classic cognitive control paradigm, i.e. the Simon task (Simon & Small, 1969). Twenty-four healthy participants were tested: both left and right DLPFC were stimulated, while vertex stimulation was considered as control condition. Results indicate that while in the control condition reaction times (RTs) were faster in the post-stimulation session, independently from trial correspondence, after left DLPFC stimulation RTs were faster only for non-correspondent (NC) trials (high conflict condition), whereas after right DLPFC stimulation RTs were faster only for the correspondent (C) ones (low conflict condition). Moreover, when we directly compared the effects of left and right DLPFC stimulation, results showed the presence of a significant modulation of the conflict adaptation effect, which on the contrary was not affected by the vertex stimulation. In conclusion, our results confirm the involvement of DLPFC in cognitive control, and appear to be in line with recent evidence reporting the presence of prefrontal hemispheric asymmetries in conflict processing (Ries *et al.*, 2014; Wittfoth *et al.*, 2009; Chambers *et al.*, 2007).

## **A10. Is Money More Attractive Than Eyes? The Interference of Monetary Reward on the Gaze Cueing Effect**

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**Keywords:** Selective visual attention, Orienting of attention, Gaze Cueing Effect, Monetary reward

Selective visual attention is a primary cognitive function that allows the selection of the most relevant stimuli in the environment by prioritizing their processing. Several studies have shown that this process of attentional selection can be influenced both by the direction suggested by the gaze (i.e. the Gaze Cueing Effect, GCE) and by the motivational valence of rewarding stimuli such as those used in monetary reward tasks (i.e. monetary reward). The aim of this study was to investigate the GCE with a modified version of Posner's paradigm, and if this effect could be modulated by a monetary reward delivered in a modified version of the Dictator Game. Results supported previous findings showing the presence of the GCE (i.e. faster responses when the target appeared in the gazed-at location), especially with relatively short SOAs. In addition, they suggested the existence of a modulatory effect of the monetary reward on the GCE in relation to the participant's gender and the side where the reward appeared. Specifically, reward mitigated the GCE since participants responded significantly faster in invalid cue-trials when the target appeared in a previously rewarded location. Therefore, the reward seems to attenuate the GCE.



## A11. Attentional bias toward faces: a TMS-EEG study

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Keywords: Social attention, TMS-EEG, FEF

Social stimuli like faces prevail over other competing stimuli without a social value. Attentional orienting triggered by social stimuli can be described as an attentional bias, but the neural mechanisms guiding social orienting remain unclear. Our aim was to explore in healthy participants the cerebral network involved in early orienting of attention toward stimuli with a social value. We used TMS combined with EEG to study the local and global cortical excitability during a modified version of the dot-probe task. A TMS pulse was applied over the right frontal eye field (FEF) during the presentation of two competing (face vs. house) or not –competing (house vs. house) stimuli. Participants were asked to detect a target that could appear in one of the two locations previously occupied by the stimuli (cues); manual RTs were recorded. We examined ERPs and TMS evoked potentials (TEPs) recorded during the cueing phase of the dot-probe task, comparing the attentional EEG components in the experimental conditions of competing vs. not-competing stimuli. Moreover, we investigated whether TMS-EEG data were related to the amount of attentional bias obtained in the dot-probe task. Preliminary data show that competing and not-competing stimuli differently modulate ERPs, while the application of the TMS pulse over right FEF induced a suppression of the differences among conditions, suggesting a key role of FEF in biasing attention towards emotional faces. In addition, the modulation of the neurophysiological response appeared to be related with the strength of the attentional bias toward faces

## **A12. Does temporal orienting impact visual short-term memory? A high spatial resolution EEG study**

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**Keywords:** Temporal orienting, Visual short-term memory, High spatial resolution, EEG, CNV, P3

The maintenance of sensory information in visual short-term memory (VSTM) can be facilitated by spatial attentional orienting. However, little is known about the effect of temporal orienting (TO) on VSTM. In the present study, thirty-five adults were asked to memorize a three-item visual array while undergoing a high spatial resolution EEG recording. After a variable inter-stimulus interval (ISI), a central, single probe was presented. Participants had to judge whether this was present or not in the memory array. Crucially, a visual cue delivered before the array provided temporally valid or neutral information about the maintenance interval (1 or 3 s). Behavioural results showed that TO improved VSTM performance for short ISI. At the neural level, this effect was mainly supported by 1) increasing amplitude of the cue-locked CNV component, an effect localized to the right occipito-temporal cortex and 2) increasing amplitude of both memory array- and probe-locked P3 amplitude, which was supported by a bilateral activation of superior parietal cortex. By contrast, the TO effect on VSTM was reversed in long-ISI trials, with participants scoring lower in temporal than neutral trials. This reversed effect was supported by reduced amplitude of the sustained, memory array-locked ERP activity. Our findings suggest an interaction between top-down, temporal attentional control and task difficulty. Specifically, performance is enhanced when the cue predicts short maintenance intervals, whereas it is disrupted when it predicts long maintenance intervals. From a theoretical point of view, these findings support the account that TO is a flexible and strategic.

### **A13. Does inter-trial interval duration influence cognitive control? The case of the SNARC effect**

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Keywords: Snarc effect, Inter-trial interval, Behavioral, Neuroimaging

A common practice in neuroimaging studies measuring stimulus-evoked brain hemodynamic responses (e.g., with fMRI or fNIRS) is to adapt paradigms originally devised to collect behavioral responses by prolonging the inter-trial interval (ITI), to allow hemodynamic responses to return to baseline. The underlying assumption is that ITI variations have no influence on studies effects. The aim of the present work was to unravel the impact of ITI duration on cognitive control and emotional state, by using a task eliciting the spatial-numerical association of response codes (SNARC) effect. The SNARC effect highlights the link between numbers and space: participants are faster to respond to small numbers with the left than the right hand and the opposite for large numbers. Thirty-four participants performed a parity judgment task in two separate counterbalanced sessions, approximately three weeks apart. The only difference between sessions was the length of the ITI (short: 1100-1500 ms vs. long: 6000-10000 ms). Before and after each session, participants were asked to complete the STAI questionnaire to evaluate their state anxiety. Results revealed a significant increase in state anxiety in the short-ITI case only, suggesting that short-ITI designs might influence more the emotional state. Analysis on reaction times (RTs) revealed slower RTs in the long-ITI vs. short-ITI design, for odd vs. even numbers and for incompatible vs. compatible trials. Furthermore, a significant interaction between ITI and SNARC effect highlighted a stronger SNARC effect in the long-ITI design. These results suggest that ITI might have a strong influence on both emotional and behavioral state.

## **A14. Distinct attentional networks track valence and utility during naturalistic search**

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Keywords: Vision, Attention, Reward, fMRI, Economics, Incentive salience

Attention is thought to be automatically biased toward reward-predictive stimuli. But this may reflect two discrete effects: attention may be drawn to stimuli with positive valence, or attention may be drawn to stimuli with value and utility. To disentangle these effects, we performed two experiments in which participants detected instances of categories of objects – cars, people, houses, trees – in briefly presented real-world scenes. Correct detection of each category was associated with one of three outcomes: gain, evasion of equivalent loss, or neutral outcome. Critically, our design was such that correct detection of gain- and loss-associated stimuli had equivalent value relative to incorrect response, and it made economic sense to select and process these stimuli in the same way. Experiment 1 was a behavioural study, and results showed an attentional bias for gain-associated stimuli but not for loss-associated stimuli. Experiment 2 was an fMRI study. Here we looked for voxels that were more active when either gain- or loss-associated targets were present in the scene (the utility model), or that were more active when gain-associated targets were present and less active when loss-associated targets were present (the valence model). Utility expressed in fronto-parietal regions associated with strategic top-down control of attention, consistent with a stronger deployment of voluntary attention to examples of both financially-beneficial categories. In contrast, valence expressed in the caudate tail, consistent with a subcortical reward-driven attentional network. These data suggest the presence of multiple attentional systems which independently modulate visual selection of motivationally relevant stimuli.

## **A15. Altering spatial priority maps via statistical learning of target selection and distractor suppression**

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Keywords: Statistical learning, Target selection, Distractor filtering, Attentional capture

In the attention domain, it is well known that the probability with which a target occurs at various spatial locations influences performance. An emerging literature has started to address changes in the efficiency of distractor suppression triggered by the unequal spatial distribution of distracting stimuli. Here we focus on these forms of learning to explore the interplay between distractor suppression and target selection mechanisms. In a series of experiments, participants had to indicate the identity of a target stimulus while ignoring a task-irrelevant distractor, when present. We systematically manipulated the spatial probabilities of either one or the other stimulus, or both: the critical stimulus (target and/or distractor) was more likely at one particular location and less at another location, with remaining locations serving as a baseline. Results showed that the distractor generated greater interference when presented at the low probability location. Also target selection differed across locations, with faster responses for targets at the frequent location. Most importantly, the unequal spatial probability of the target affected the distractor effect, and vice versa, with greater distractor interference for the location with higher target probability and faster target identification for the location with rare distractors. These results demonstrate that distractor suppression and target selection reflect at least partly shared underlying mechanisms.

## A16. From Math to Mind

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Keywords: Machine Learning, P300, Feature Selection, BCI

The detection of brain state changes can dramatically improve the comprehension of cerebral functioning. To reach this aim, machine learning based automatic tools may be extremely useful to correctly classify different brain responses. The performance of these instruments depend on the features and the classification algorithm employed, but also from a good data preprocessing able to improve the poor signal- to-noise ratio of the EEG signal. In this work, we combine data preprocessing with a feature selection based on the filter ReliefF and the linear SVM classifier LibLinear in order to analyse the data deriving from a P300 speller paradigm on patients with Amyotrophic lateral sclerosis (ALS), belonging to the BNCI Horizon 2020 database. The purpose of this study is twofold: on the one hand we want to maximize the predictor's performance, but most importantly, we aim at showing how the features ranking can be used to support scientific hypotheses or diagnoses. The reported results show how our approach represents a valid alternative to the widely used SWLDA, since it provides results comparable to SWLDA in terms of accuracy and Cohen's Kappa, but selecting features that are physiologically relevant while the features selected by SWLDA show scarce correlation with the ERPs. This kind of information might furnish relevant insights to identify which brain areas and when are involved during certain cerebral activities, thus improving the comprehension of brain functioning and furnishing a valuable instrument for supporting either neurophysiological insights or clinical hypotheses.

## **A17. Can a set of cognitive trainings of executive functions improve perceptual processing speed?**

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Keywords: Cognitive training, Executive functions, Perceptual processing speed

**Study goals:** There is an ongoing debate about the effects of computerised cognitive trainings (CCT). Whereas some authors claim that there is no reliable evidence of their effectiveness, others suggest that they may have a far transfer on other non- trained processes from more basic perceptual level. The aim of the study was to examine whether an intensive training of executive functions can improve some higher-order cognitive processes and whether it affects the general perceptual processing speed. **Methods:** 123 participants, aged 19-31 ( $M = 23.33$ ,  $SD = 2.65$ ), were tested in the pre- and post-test with the Inspection Time Test (ITT) to measure their perceptual processing speed and with a set of widely used measures of working memory and attentional system. Divided in two groups: experimental ( $N = 61$ , 52.7% female) and control ( $N = 63$ , 48.2% female), they completed 18 training sessions (40 min/day). Training consisted of practicing three tasks that are considered to improve updating, inhibition, and switching functions. The experimental group trained on an adaptive version of these tasks, while the control group completed a non-adaptive placebo training. **Results:** Although the experimental group performed significantly worse in the ITT than controls in pre-test, adaptive training eliminated these differences in the post- test. Both groups improved their processing speed after the training, however, the effect size was greater in the experimental group. No higher-order executive functions came out to be affected by the training. **Conclusions:** We showed that an intensive CCT leads to improvement of basic perceptual processing speed, but has no effect on higher-order cognitive functions.

## **A18. Cognitive conflict in a modality switching Simon task**

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Keywords: Simon task, Modality switching, Cognitive conflict, Theta power, Vision Touch

In the context of the Simon task, cognitive conflict is generated by a competition between the automatic reactions induced by stimulus location and the task-relevant response. This conflict is reflected in brain activity as a stronger increase in the power of theta oscillations (5-7 Hz) for incompatible, compared to compatible trials. Previous behavioral evidence demonstrated that when visual and tactile trials are mixed unpredictably, the visual Simon effect vanishes, while the tactile Simon effect remains. In this case there are two possible sources of cognitive conflict: spatial representations and modality switching, which might interact. In the present study we aimed at investigating the neurophysiologic expression of cognitive conflict mechanisms in terms of theta (5-7 Hz) power modulation in a modality switching Simon task. Participants performed four versions of the Simon task, in an EEG protocol: 1) single modality visual, 2) single modality tactile, 3) mixed modality visual-tactile, 4) single modality visual post-test. In all single modality versions of the task, we replicated previous evidence concerning conflict modulation of theta power (incompatible > compatible). However, conflict modulation of theta power was no longer present in the modality switching Simon task, for either visual or tactile trials. The present results highlight an interaction involving conflict between spatial representation and modality switching.



## **A19. Tonic noradrenergic activity is related to attentional set shifting – evidence from pupillometry**

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**Keywords:** Attentional set shifting, Exploration-exploitation tradeoff, Noradrenergic transmission, Wisconsin Card Sorting Task, Intra/Extradimensional Set Shifting Task

A constant task for every living organism is to decide between the exploitation of current rewards and the exploration of the environment for more rewarding options. An important cognitive function underlying the trade-off between exploration and exploitation is attentional set shifting, which enables flexible switching between task-related and task-irrelevant information. Current empirical evidence (see e.g. Aston-Jones & Cohen, 2005; Bouret & Sara 2005) indicates that exploitation is related to phasic, whereas exploration is associated with tonic firing mode of noradrenergic neurons in the locus coeruleus (LC). Because pupil dilation is suggested to be correlated with LC activity (see e.g. Murphy *et al.*, 2014), we used pupillometry to demonstrate a link between noradrenergic transmission produced by the LC and attentional set shifting in humans. We used the Wisconsin Card Sorting Task and the Intra/Extradimensional Set Shifting Task to assess attentional set shifting. In these tasks, participants chose between different compound stimuli. The stimulus-reward contingencies change periodically, thus participants are repeatedly required to reassess which stimulus-features are relevant. Our results showed that baseline pupil diameter, assessing tonic noradrenergic activity, steadily decreased during stable stimulus-reward contingencies, whereas it suddenly increased after changes in these contingencies. Thus, our results suggest that tonic firing mode of noradrenergic neurons in the LC is implicated in attentional set shifting, as it regulates the amount of exploration.

## **A20. The more, the worse? – beneficial impacts of secondary task dynamics on cognitive flexibility**

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Keywords: Task-switching, Dual-task, Memory

People are remarkably good at flexibly interchanging current goals. Yet, this rapid updating of actual goals usually incurs a cost in performance (i.e., task switch cost). The cause for this worse performance after exchanging current goals remains elusive. Whereas one line of research attributes the origin of this cost to executive control processes engaged in the re-configuration of performance-guiding task-sets (i.e. cognitive representation of a task), the alternative account attributes this cost more to lingering episodic bindings from prior task performance. Our study aimed at providing further data to stimulate the discussion about the mechanisms underlying this cost. To this end, we enriched a standard task switching paradigm (i.e. odd/even vs. high/low classification) with secondary tasks that differed in their dynamics (i.e. uttering words or repeating a gesture compared to holding a spittle or pressing down keys on a keyboard) as well as their effectors (using vocalization as well as manual gestures). We found beneficial effects of our dynamics secondary task in that those reduced the observed costs when participants had to switch the task. In contrast, in our control condition, in which no secondary task was performed, sizable switch costs were observed. We interpret this finding in line with the memory-account of task switch cost, namely that the introduction of a secondary tasks hampers the buildup of memory traces that are beneficial in case of a task repetition but harmful in case of a goal change (i.e., task switch).

## **A21. Lateral frontal areas trigger attentional switches after negative feedback in a variant of the Wisconsin card sorting task**

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**Keywords:** Negative feedback, Attentional switching, Fronto-lateral cortex, MVPA

In a changing environment, we need to flexibly adjust our behaviour to the current task demands. When our performance is worse than expected due to changes in the environment, we might need to adjust our attentional focus. The present study required participants to respond to one of three possible stimulus features (colour, motion direction or face gender). The relevant feature unpredictably changed every few trials. Auditory feedback was provided so that individuals could infer when a change had happened, and prepare themselves for responding to a different feature in the following trial. Importantly, participants were not told which feature would be relevant. By using a multivariate searchlight analysis of fMRI data, we investigated if it is possible to identify brain areas that show different activity patterns depending on the stimulus feature that the individual intends to respond to in the following trial. Above-chance decoding in areas within the inferior frontal junction, inferior frontal sulcus and dorsal occipital cortex of the left hemisphere as well as the intraparietal sulcus bilaterally suggests that these areas show differential activity for switching to each of the three visual features. The results indicate that these brain areas are not only active in response to switching in general, but show a specific activity pattern for switching attention to colour, motion or faces, respectively.

## **A22. Interactive effects of cycle phase and dopamine baseline levels on higher cognitive functions**

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**Keywords:** Menstrual cycle, Estradiol, Progesterone, Dopamine, Executive functions, Eye Blink Rate, Stroop, N-back, Working memory, Cognitive flexibility

Sex hormones have multiple effects on the dopaminergic system, which relates to executive functions in an ‘inverted u-shaped’ manner with different dopamine optima for different functions. Accordingly, it has been demonstrated that inhibitory functions of working memory are enhanced or impaired during the pre-ovulatory cycle phase depending on dopamine baseline levels. Therefore, our main goals were to extend these findings (i) to the luteal cycle phase and (ii) to other executive functions. Furthermore, the usefulness of the eye blink rate (EBR) as an indicator of dopamine baseline levels in menstrual cycle research was explored. Thirty-six naturally cycling women were tested in three cycle phases (menses, pre-ovulatory and luteal) and performed a verbal N-back task as a measure of working memory and a Stroop task as a measure of cognitive flexibility. Hormone levels were assessed from saliva samples and spontaneous EBR was recorded during menses as an indicator of striatal dopamine levels. Interactive effects between cycle phase and EBR were found for the Stroop color condition, driven by the luteal phase and progesterone levels. During the luteal phase, women with higher EBR performed worse, whereas women with lower EBR performed better. In the N-back task, performance was enhanced during the luteal phase and related to progesterone levels irrespective of dopamine baseline levels. Additionally, the EBR was identified as a useful dopamine indicator in menstrual cycle research. The evidence presented here extends the idea of DA-cycle interactions to other cognitive functions and suggests an important role of progesterone in modulating these interactions.

## A23. Deception and Executive Functions

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Keywords: Deception and executive functions, Deception and executive control, Task switching in deception

The main aim of this research is to investigate the role of the executive functions in the lying activity and to identify the neural correlates of deception. A systematic review of the literature published on pubmed using ad hoc keywords linked to deception and executive control. Researches have shown that lying considerably challenge our cognitive capacities. Empirical evidences support the hypothesis that lying is cognitively more demanding than telling the truth. Studies support the notion that while lying: working memory enables to keep the truth active; inhibition response is required to suppress the dominant response (truth); shifting response is needed to flexibly shift between truthful and deceptive responses. Brain imaging studies consistently found higher activity of the prefrontal cortex and the inferior frontal gyrus while lying. In conclusion, prefrontal cortex is crucially linked to executive functions. Working memory, response inhibition and task switching seem to play a significant role in the deception. Deception researches largely ignored the cognitive cost of lying and further studies may be useful to investigate the role of task switching in deception.

## **A24. Left Inferior Frontal Gyrus (LIFG) as the neural common ground for behavioral and cognitive control**

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**Keywords:** self-control, Cognitive control, Behavioral control, Executive functions, Attention Network Task, Functional Magnetic Resonance Imaging, Inferior frontal gyrus, Anterior cingulate cortex, Middle frontal gyrus, Superior frontal gyrus, Initiation and persistence, Goal maintenance

Self-control can be considered on three levels: behavioral, cognitive and neural (Nečka, 2015). Most studies incorporate only one or two levels, therefore it is difficult to narrow down a focal point for all. Ability to control oneself and cognitive executive functions are closely related, but separate constructs (Chuderski, 2010). A number of brain areas correlate to behavioral and cognitive level, often overlapping each other. The goal of this study was to provide insight from brain analysis, on cognitive and behavioral control relationship and suggest the neural common ground for self-control. 35 participants (57% female) took part in the research. The behavioral control was assessed by Self-Control Scale AS-36 (Nečka, 2015). Cognitive control was measured by the executive component of Attention Network Task (ANT; Fan *et al.*, 2002). Event-related functional magnetic resonance imaging (fMRI) was used to capture neural activation. The AS-36 scores were correlated to activation level in selected regions of interest (ROI). As expected, we observed significant activation in right Anterior Cingulate Cortex (RACC), left Superior Frontal Gyrus (LSFG), bilateral Inferior Frontal Gyrus (LIFG and RIFG) and right Middle Frontal Gyrus (RMFG). Only the activation of left IFG (LIFG) was significantly positively correlated with general score in AS-36 and its 2 subscales – Goal Maintenance (GM) and Initiation and Persistence (IP). The results are consistent with previous studies on neural correlates of cognitive and behavioral control. We suggest the LIFG as a brain substrate of integrated self-control that constitutes a neural behavioral and cognitive common ground.

## **A25. Self-Control and Executive Function Tasks Relations: A Multi- Dimensional Approach**

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Keywords: Executive function, Self-control, Multi-dimensional approach, Distractor type

Extensive evidence shows little, if any, correlation between self-control (SC) and executive functions (EF). Existing explanations suggest that this is due to methodological limitations, rather than the lack of an actual relationship. We replaced the correlational design with an experimental one and we examined the effectiveness of inhibition depending not only on the overall self-control trait, but on its components. Specifically, we asked the question: What mechanisms of SC are involved in dealing with a distraction during EF tasks performance? In two experiments we measured SC with NAS-50 questionnaire consisting of five subscales, and used Corsi Block-Tapping Task (CBTT) adapted to assess resistance to distractors of varying degree of interference. The experiments differed in the distractor type used in CBTT – affectively positive, aversive, and neutral photos in Exp.1 (N = 74), and distractors related and unrelated to Self in Exp.2 (N = 87), e.g. photos of participants or celebrities. Results showed no relationship between overall NAS-50 score and EF tasks performance. However, NAS-50 subscales – ‘Inhibition and Adjournalment’ and ‘Initiative and Persistence’ (Exp.1), and ‘Switching and Flexibility’ (Exp.2) – differently affected the EF task performance in both experiments. Also, the aversive stimuli captured attention more strongly than the neutral ones, which resulted in a lower number of hits in the memory task (Exp.1). In Exp.2 the distractor category had no influence on performance. Our study suggests that the use of multi-dimensional SC measures and EF task performance measures allow for a better assessment of the functional significance of variables related to both constructs.

## **A26. Cognitive control sensitizes attention to biologically salient pictures: an EEG study**

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Keywords: cognitive control, flanker task, task-irrelevant stimuli, attention, LPP, effective connectivity

The detection of cognitive conflict is thought to trigger adjustments in executive functions. It has been recently shown that cognitive conflict increases processing of stimuli that are relevant to the ongoing task and that these modulations are exerted by the dorsolateral prefrontal cortex (DLPFC). However, it is still unclear whether such control influences are unspecific and might also affect the processing of task-irrelevant stimuli. The aim of the study was to examine if cognitive conflict affects processing of neutral and negative, task-irrelevant pictures. Participants responded to congruent (non-conflict) or to incongruent (conflict-eliciting) trials of a modified flanker task. Each response was followed by a presentation of a neutral or negative picture. The late positive potential (LPP) in response to picture presentation was used to assess the level of picture processing after conflict vs non-conflict trials. Connectivity patterns from DLPFC towards attentional and perceptual areas during picture presentation were analysed to check if DLPFC might be a source of these modulations. ERP results showed an effect of cognitive conflict only on processing of negative pictures: LPP in response to negative pictures was increased after a conflict trial, whereas LPP in response to neutral pictures remained unchanged. Cortical connectivity analysis showed that conflict trials intensified information flow from the DLPFC towards attentional and perceptual regions. Results suggest that cognitive conflict increases processing of task-irrelevant stimuli; however, they must display high biological salience. Increase in cognitive control exerted by DLPFC over attentional and perceptual regions might be a probable mechanism of the effect.



## **A27. Electro-cortical markers of performance monitoring code observed errors rather than their proportion: a combined EEG and immersive virtual reality study**

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Keywords: Error monitoring, Cortical oscillations, Immersive virtual reality

Electro-cortical signatures of performance errors are thought to indicate the need for top-down control. Mid-frontal theta oscillatory activity (4-8 Hz) is a well-established marker of committed or observed errors. By combining EEG and immersive virtual reality, we reported that observing errors in reach-to- grasp actions of an avatar seen from a first-person perspective elicited greater theta oscillations over fronto-central electrodes (Pavone *et al.*, 2016). Previous studies on committed or observed errors used sequences of trials where erroneous actions were less frequent than correct actions (e.g. 30% vs 70%). Therefore, it was not possible to disentangle whether the activation of the performance system was due to error per se or to surprise/novelty effect associated with rare and less predictable events. To address this issue, we recorded the EEG signal of 20 participants observing correct or erroneous actions performed by an avatar. Importantly, at variance with Pavone *et al.* (2016) the proportion of erroneous vs correct actions was 70% vs 30%. The results show that observation of erroneous actions enhanced theta power compared to correct actions. Our data suggest that error per se, and not its percentage of occurrence, triggered the activity of the performance monitoring system, likely with the aim of flexibly adapting actions to the challenges of the external environment.

## **A28. The right prefrontal cortex supports suppression of competing memories: an investigation with Transcranial Direct Current Stimulation**

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**Keywords:** Memory, Cognitive control, Inhibition, Transcranial Direct Current Stimulation, Retrieval-induced forgetting, Stop-signal task

Across two experiments, we sought to investigate the necessity of the right Prefrontal Cortex in successful control over interfering memories during selective retrieval, as indexed by the retrieval-induced forgetting effect (RIF), and the relationship between this ability and efficient motor stopping. To this end, we recruited 53 (experiment 1) and 72 (experiment 2) healthy volunteers, which were randomly assigned to three groups that received either anodal, cathodal, or sham transcranial Direct Current Stimulation (tDCS) to the right Inferior Frontal Gyrus while performing a standard retrieval-practice paradigm with category-exemplars word pairs, which is typically employed to induce RIF. In experiment 2 participants also performed a stop-signal task (SST) during tDCS. We analyzed memory performance data by fitting logistic mixed effects models in R, with item type, stimulation group, and the possible interaction term as fixed effects, and subject and category as random intercept terms, in order to account for both subject- and item-related variability. In both experiments, RIF was impaired under real tDCS compared to sham tDCS, but only for a subset of the stimulus categories. In addition to that, we did not find neither effects of tDCS on motor stopping performance in the SST, nor a relationship between motor stopping and memory control abilities. Overall, our results support the notion that tDCS over the right Prefrontal Cortex can alter memory control performance as indexed by RIF. However, further studies are needed in order to clarify the factors that moderate the effects of tDCS on RIF across different stimulus categories.

## **A29. Error monitoring and arousal: insights from on-line TMS**

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Keywords: Error Monitoring, Arousal, Transcranial Magnetic Stimulation

Error Monitoring (EM) is an adaptive process that triggers cognitive, metacognitive and behavioral compensatory adjustments when the performance is suboptimal (Ullsperger *et al.*, 2014). In the present research we investigated the neural and functional bases of EM using the transcranial magnetic stimulation (TMS) during the execution of a modified version of the Error Awareness Task (EAT, Hester *et al.*, 2005). Specifically, we investigated the role of the dorso-lateral prefrontal cortex (DLPFC) in EM. Furthermore, we studied how the stimulation of different time windows within the time course of EM could produce selective timing-dependent effects. We implemented two studies in which each participant was stimulated using the TMS during three different sessions and on three different brain areas: the right DLPFC, the left DLPFC and the Vertex (control site). In the first study 20 participants (mean age: 22.5) completed the EAT during a double-pulse TMS protocol. This experimental group was compared with a control group (n = 18, mean age 25.5) without TMS. In the second study 20 participants (mean age: 24.6) performed the EAT during a single-pulse TMS protocol. Results of the first study suggest that EM is a process highly arousal-dependent. In fact, experimental group's participants show a faster emergence of error awareness than control group's participants. In the second study we confirm the causal role of the bilateral DLPFC activity in EM. Finally, results of both studies suggest different cognitive, clinical and methodological implications.

## **A30. Microsaccades and pupil dilation uncover preparatory mechanisms in the generation of pro- and anti-saccades**

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Keywords: Pro-saccade, Anti-saccade, Preparatory set, Pupil dilation, Microsaccades

The ability to generate flexible oculomotor behaviours is crucial for obtaining efficient interactions with the environment. In this regard, the anti-saccade task represents a valid tool to investigate the capacity to inhibit an automatic eye movement (pro-saccade) towards a target that suddenly appears in the visual field, in favour of a voluntary eye movement (anti-saccade) towards the opposite location. In the present study, we investigated whether the preparatory mechanisms involved in the programming of pro- and anti-saccades were reflected in both pupil dilation and fixational eye movements (i.e., microsaccades). On each trial, participants were asked to prepare a pro- or an anti-saccade depending on a symbolic cue that appeared at fixation for 2000 ms. After that, a target appeared rightwards or leftwards and participants were asked to perform the required eye movement as fast and accurate as possible. After target onset, smaller latencies and greater accuracies emerged for pro-saccades as compared to anti-saccades. More intriguingly, we also observed that, in the 2000-ms preparing interval, smaller pupil dilation and more microsaccades emerged when participants were instructed to program a pro-saccade rather than an anti-saccade. Overall, these results shed fresh light on the intriguing interplay between oculomotor dynamics and response preparation, and invite to consider both pupil dilation and microsaccades as valid indicators for ongoing cognitive processing.

## **A31. Flanker task with equiprobable congruent and incongruent conditions does not elicit the conflict N2**

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Keywords: Cognitive control, ERP, N2, Inhibition, Attention, Flanker task

In many published studies, various modifications of the flanker task have been used. Regardless of a particular version of the task employed, the conflict N2 component has been consistently reported and interpreted as evidence for involvement of inhibition in resolution of conflict introduced by incongruent flankers. However, the ERP studies that use the most basic version of the flanker task (i.e. without additional manipulations tapping cognitive control) do not provide a compelling evidence for the conflict N2 component. We report results of a large-sample ERP study employing a basic flanker task that allowed us to revisit mechanisms underlying resolution of conflict introduced by the incongruent flankers. We tested 58 participants three times across a span of 2 years. In the behavioral data, we observed the classical effect of congruency. In the ERP data, we found three conflict-sensitive components: 1) an early frontal component, presumably corresponding to P2; 2) P300 for congruent trials followed by 3) P300 for incongruent trials. Contrary to previous studies, we did not find evidence for the conflict N2 component. We argue that what is sometimes interpreted as the conflict N2 component observed in a basic flanker task, might actually be a frontal aspect of P300 component. The absence of the conflict N2 in the basic flanker task suggests that conflict induced by the incongruent flankers is resolved without involvement of response inhibition. The observed P2 component suggests that selective attention might be a mechanism underlying resolution of conflict elicited by the flankers.

## **A32. Neural mechanisms of proactive and reactive cognitive control in a rewarded Stroop task: A simultaneous EEG-fMRI study**

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Keywords: Neuroimaging, Reward, Stroop, Control, EEG

Reward is known to boost performance in cognitive tasks. Monetary incentive delay tasks (MID; cue-locked reward information on the trial level) and stimulus-reward association tasks (SRA; target-locked reward information on the feature/item level for a subset of stimuli) are typically used to study the effect of reward on cognitive- control mechanisms. Neuroimaging results of studies using SRA paradigms suggest that reward could particularly enhance reactive control and maybe specific item-/feature-level proactive control, whereas in MID tasks more global shifts from reactive to proactive control are observed in reward context. Yet, direct comparisons between these different reward manipulations are lacking. We conducted a simultaneous EEG-fMRI study with a mixed event-related / block design to investigate and compare cognitive control mechanisms in a rewarded Stroop task. In addition to the SRA, the MID and neutral block, we implemented the Cued-SRA block (C-SRA; cues were reward irrelevant but matched the temporal MID structure). Behavioral results showed main effects of reward and congruency for all reward- related blocks. Preliminary ERP analysis of the cues resulted in more robust attention and expectancy effects in the MID block compared to the C-SRA block speaking in favor of proactive control mechanism in the MID task. In addition, both the EEG data and the fMRI data show a varied pattern of activity related to valuation and task implementation indicative of subtle differences across the different reward conditions. Together, the present results highlight the flexible manner in which reward effects can arise, and the usefulness of simultaneous EEG-fMRI in cognitive neuroscience.

### **A33. The role of subcortical mechanisms in executive functions – Evidence from the Stroop task**

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**Keywords:** Stroop effect, Subcortical Regions, Monocular stimulation, Task-switching

The literature has long emphasized the role of the cerebral cortex in executive functions. Recently, however, several researchers have suggested that subcortical areas might also be involved in executive functions. The current study explored the possibility that subcortical mechanisms have a functional role in adaptive resolution of Stroop interference. We asked 20 participants to complete a cued task-switching Stroop task with variable cue-target intervals (CTI). Using a stereoscope, we manipulated which eye was shown the relevant dimension and which was shown the irrelevant dimension. This technique allowed us to examine the involvement of monocularly segregated – subcortical – regions of the visual processing stream. The interference effect was modulated by this eye-of-origin manipulation in the 0 CTI condition. This finding provides a novel indication for the notion that subcortical regions have a functional role in the resolution of Stroop interference. This indication suggests that cortical regions are not solely involved and that a dynamic interaction between cortical and subcortical regions is involved in executive functions.

### **A34. Simulating and testing the linear strength of brain response to the conflict level**

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Keywords: Conflict monitoring, Stroop task, N450, Electroencephalography

Several existing theories of executive control attempted to explain the origins of the negative deflection (the N200/N450 wave) widely observed in the electroencephalographic (EEG) signal, which emerges in conflict tasks (e.g., the Stroop, flankers). However, existing research examined the sole presence/absence of conflict, but not its exact level. Here, we used a novel variant of the computational model of conflict monitoring in order to simulate the N450 wave in a modified Stroop task that allowed multiple correct responses for target colors, as well as multiple incorrect responses for distractor words. According to the Festinger formula, the level of conflict was evaluated as the proportion of incorrect responses among all activated responses. The model predicted that a larger number of activated incorrect responses (i.e., a presumably higher conflict) would entail a more pronounced N450 wave. This prediction was confirmed by a subsequent EEG study ( $N = 33$ ) showing that two components of the N450 wave, parietal negativity and medial frontal negativity, were more negatively deflected when conflict was higher, than when it was lower, visibly responding to the level of conflict. These results can be plausibly explained by the conflict monitoring theory with a modified conflict evaluation formula, whereas they are at odds with several alternative theories of cognitive control, because the time on task, the proportion of errors, the target- distractor contingency, as well as several other factors, postulated by those theories to elicit N200/N450, did not differ between the low- and high-conflict trials.



## **A35. Momentary changes in the connectome topology predict performance on the reasoning tests**

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Keywords: Fluid reasoning, EEG, Connectome

Correct performance on the abstract reasoning tests strongly involves effective control over thought and behavior. Several recent studies attempted to predict individual differences in such a performance (fluid intelligence) using functional connectome – the network reflecting the flow of BOLD (or EEG) signals. However, existing studies bring inconsistent results: some report null correlations with fluid intelligence, some reveal the local effects at particular hubs or edges, whereas others suggest differences in global topology of the network. This discrepancy might be due to the fact that to date most studies analyzed averaged connectomes. We collected EEG data while 50 people were solving the matrix and transitive reasoning tasks. Using a novel data analysis method, we calculated connectomes separately for consecutive frequency bands and for particular events in each task (problem presentation, processing interval, response option presentation etc.). Then, we analysed the connectome topological indices (efficiency and clustering). The indices for the alpha, beta and gamma bands successfully differentiated reasoning from the resting state, and predicted the processing of particular events. Most importantly, unlike during other intervals, on the key events a larger efficiency and stronger clustering (an increased small worldness of the network) predicted both correct versus incorrect performance on particular task items and the fluid intelligence level of a given person. The results suggest that the network of information flow in the human brain has highly dynamic nature, and its optimal topological features are especially beneficial for executive control during the key moments of the task performed.

## **A36. The common elements of executive functions and intelligence**

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Keywords: Intelligence, Factor analysis, Principal Component Analysis

The current study examines the common elements of executive functions (EFs) and intelligence using factor analytic approach. Data of  $N = 126$  individuals aged 18-88 years from five subtests of the Executive Functions Module of the German Neuropsychological Assessment Battery (NAB) and ten core subtests of the German Wechsler Adult Intelligence Scale – Fourth Edition (WAIS-IV) were used to examine the common factors underlying the two measures. The Principal Components Analysis with promax rotation revealed four substantially intercorrelated first-order- factors; thus, the Schmid-Leiman procedure was employed to extract a second- order-factor. The subtests' loadings were most substantial for the second-order- factor representing general intelligence ( $g$ ;  $h^2 = 5.62$ ); the average loading for the WAIS-IV subtests was .65, and for the NAB subtests .51. When considering the first- order-factors, most of the subtests (WAIS-IV Similarities, Vocabulary, Information; NAB Categories, Letter Fluency, Word Generation) loaded on a factor representing verbal abilities ( $h^2 = 1.06$ ). The WAIS-IV Block Design and Visual Puzzles mostly loaded on a factor representing visual abilities ( $h^2 = 0.88$ ). The WAIS-IV Symbol Search and Coding, and the NAB Mazes mostly loaded on a speed-related factor ( $h^2 = 0.92$ ). The WAIS-IV Digit Span, Matrix Reasoning, Arithmetic, and the NAB Judgment mostly loaded on a factor combining fluid reasoning and working memory (WM) ( $h^2 = 0.95$ ). The results demonstrate that EFs and intelligence have strong common elements and cannot be clearly distinguished. Interestingly, the NAB subtests appear to assess not only  $g$  to a considerable extent but also specific cognitive abilities, particularly language.

## **A37. Monetary incentives influence cognitive control networks via anterior cingulate functional connectivity**

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**Keywords:** Cognitive control, Functional Magnetic Resonance Imaging, Reward, Punishment, Incentives, Anterior cingulate cortex

Incentives are the primary determinants of if and how well an organism will perform a given behaviour. Here, we examined how incentive valence and magnitude influence task switching, a critical cognitive control process, and test the prediction that the anterior cingulate cortex (ACC) will function as a key link between motivation and control systems in the brain. Thirty young adults (mean age: 24, 15 F) performed an incentivised version of a cognitive control task in the scanner. Data was analysed using 5x2 repeated measures ANOVAs with incentive (5 levels: reward high, reward low, neutral, punishment low, punishment high) and trial type (2 levels: repeat trials, switch trials) as within-subject factors. Behaviourally, high incentives (reward and punishment) improved accuracy but only high reward shortened reaction times. The fMRI data shows that neural responses to reward and punishment differed as a function of individual sensitivity to each incentive. These individual differences were present at the level of both local activity and task-dependent functional connectivity with the ACC. Our functional connectivity results are consistent with the idea that the ACC computes the utility of engaging cognitive control processes given the current costs and benefits and serves as an interface between motivation and control networks. Overall, our findings indicate that similar changes in observed behaviour (e.g. response accuracy) under reward and punishment incentives are mediated by distinct neurobiological substrates and that there are substantial individual differences in the neural response to incentivizing cognitive control, particularly as a function of reward sensitivity.

## **A38. Executive functioning, cognitive skills, and decision-making competence**

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**Keywords:** Decision making, Executive functioning, Cognitive skills, Individual differences

Although some studies have investigated the relationship between cognitive abilities and decision making, very few have characterized the specific cognitive skills underlying different facets of decision-making competence. Indeed, the scope of neuropsychological/neuroscientific studies has been very narrow, with the vast majority of investigations focusing on few specific risky choice tasks (e.g., Iowa Gambling Task, Balloon Analogue Risk Task) and on a rather limited set of variables/predictors. As a consequence, we know very little on the relation between executive functioning, cognitive abilities, and decision making. In the past five years, we have carried out a series of (behavioral) individual differences studies in younger and older adults, as well as some studies in special populations (ADHD, schizophrenia), with the aim of investigating the cognitive underpinnings of various aspects of decision-making competence, covering decision-making skills involved both in well-structured and ill-structured decisions. We will present converging evidence from five of these studies showing that (1) decision-making competence is not a unitary construct and different facets of competence rely on diverse cognitive skills; (2) different decision-making tasks differ sharply in their executive control and fluid skills demands; (3) executive control demands are task-specific and explain individual differences in aspects of decision-making competence even after controlling for more general cognitive abilities; (4) performance in decision-making tasks requiring more control and working memory resources declines with age and in specific populations; (5) ill-structured aspects of decision making specifically require divergent skills. Implications of our findings for psychological and cognitive neuroscience accounts will be discussed.

### **A39. Identification of prefrontal ERPs from the anterior insula and their association with executive functions**

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Keywords: ERPs, Decision-making, Anterior insula

Executive functions are crucial for action control, especially in the context of decision-making tasks. Despite electrophysiological techniques represent an excellent tool to investigate the fast succession of these functions, ERPs were mostly adopted to investigate the late cognitive processes, which follow the decision. In various studies, we identified the prefrontal ERPs involved in decision-making, ranging from stimulus identification to behavioral response. We described three consecutive post-stimulus prefrontal ERPs detectable in simple and complex visuo-motor tasks, and during passive viewing: the prefrontal N1 (pN1 at 100 ms), P1 (pP1 at 180 ms) and P2 (pP2 at 300 ms). These prefrontal components are affected by the task (passive viewing, response to any stimulus and to targets only) and the visual characteristics of the stimuli (stimulus luminance). Analyses were performed on different types of behavioral performance (correct trials, commission and omission errors), and with different techniques (EEG and EEG-fMRI) and source localization methods (BESA and sLORETA). The results of these studies pointed out a considerable role of the bilateral anterior insula in eliciting these prefrontal ERPs. The early pN1 and pP1 were modulated by the visual characteristics of the stimuli and the motor demands of the task, respectively. In contrast, the pP2 reflected the categorization process predicting the subsequent decision in terms of stimulus category (target or non-target) and action performance (correct or erroneous decision, and response speed).

## **A40. Active and passive listeners differences in evidence integration in natural acoustic textures**

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**Keywords:** Natural stimuli, Stimulus statistics, Decision making, Evidence integration, EEG

Natural sounds such as wind, fire or rain, are often characterized by the statistical occurrence of their constituents. Listeners can easily detect changes in these so- called acoustic textures, despite their complexities and highly variable spectro- temporal structures. Here we investigated the neural representation of change detection in natural textures and tested whether active task engagement is required for their neural representation. Subjects listened to natural textures whose spectro- temporal statistics were modified at variable times by a variable amount. Subjects were instructed to either report the detection of changes (active) or to passively listen to the stimuli (passive). A subset of passive subjects had performed the active task before and was selected for additional analysis (passive-aware vs. passive-naive comparison). Psychophysically, longer estimation of pre-change statistics was correlated with shorter reaction times and better performance. The EEG results revealed acoustic stimulus representation in auditory cortex, however, the change in statistics was barely detectable in this location. Conversely, it was robustly represented in parieto-occipital region, revealing that size and build-up rate scales related with change size and change time. Similar but reduced effects were observed in the passive-aware condition. In passive-naive, potentials still depended significantly on the change, however, with less monotonic relationships. In summary, the detection of statistical changes in natural acoustic textures is neurally reflected in parietal locations. The scaling in magnitude across different levels of task involvement suggests context-dependent degrees of evidence integration.

## **A41. Neural Representations of Hierarchical Rule Sets: the Human Control System Represents Rules Irrespective of Their Hierarchical Level**

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**Keywords:** Cognitive control, Rule representation, Task sets, Ventrolateral, prefrontal cortex, MVPA decoding

Humans use rules to organize their actions to achieve specific goals. While simple rules that link a sensory stimulus to one response may suffice in some situations, often the application of multiple, hierarchically organized rules is required. Recent theories suggest that progressively higher level rules are encoded along an anterior-to-posterior gradient within PFC. While some work supports the existence of such a functional gradient, other studies argue for a lesser degree of specialization within PFC. We used fMRI to investigate whether rules at different hierarchical levels are represented at distinct locations in the brain or encoded by a single system. Participants (N = 37) had to represent and apply hierarchical rule sets containing one lower-level stimulus-response rule and one higher-level selection rule. We used multivariate pattern analysis to directly investigate the representation of rules at each hierarchical level in absence of information about rules from other levels or other task-related information, thus providing for the first time a clear identification of low- and high-level rule representations. We could decode low- and high-level rules from local patterns of brain activity within a wide frontoparietal network. However, no significant difference existed between regions encoding representations of rules from both levels, except for precentral gyrus that represented only low- level rule information. Our findings suggest that the brain represents conditional rules irrespective of their hierarchical level and thus that the human control system is not organized according to this dimension.

## **A42. Who does what? Neural Representation of One's Own Subtask, a Partner's Subtask, and of Subtask Assignment**

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**Keywords:** Coordination, Task representations, Joint Action, fMRI, MVPA decoding

Humans often coordinate their actions to more effectively reach shared goals. Previous studies have shown that people co-represent different parts of a general task when they carry it out together, even if the representation of the other's subtask is not necessary to perform their part of the task. However, it is still unclear how these task representations are encoded at the neural level. In this study, we used multivariate pattern classification on functional magnetic resonance imaging data to identify brain regions encoding either a player's or a partner's subtask. Twenty-four participants played a collaborative game in pairs. To win the game, the players had to consider both their own and the other's subtask. The shared task consisted in moving two pawns on a graphic path to match their positions. Each player moved one of the two pawns as specified by the subtask assigned to them. Importantly, the same subtask was assigned to one subject on some trials and to their partner on other trials. Despite that, subtask information was encoded in partially different brain networks depending on whom the subtask was assigned to: Ventrolateral and rostrolateral prefrontal cortex (RLPFC) encoded only information about the player's subtask, while medial prefrontal cortex (mPFC), temporal cortex, and insula only about the partner's subtask. RLPFC and mPFC represented also information about who performs a task. These findings suggest that task ownership determines where information about an active task is represented across the brain.



## A43. Long range connectivity patterns reflect progressive learning and global strategy shifts

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**Keywords:** Time-dependent connectivity, Network neuroscience, Learning, Strategy change

With repetition, people learn and improve their performance in a task by incremental optimization of the implemented strategy or by discovering a new more effective strategy. We re-analyzed a recent fMRI experiment (Schuck *et al.*, Neuron 86.1:331-340) where subjects had to press buttons based on spatial features of the visual stimulus – the instructed strategy – or based on the stimulus color – a more effective but uninstructed strategy. Here we used a new fMRI analysis: Coherence Density Peak Clustering (CPDC, Allegra *et al.*, Hum.Brain.Mapp. 38.3:1421-1437), to investigate brain network dynamics and its association with learning. Using CDPC with sliding-windows allows to cluster voxels with similar time-series in the activation level and to integrate the resulting information in a connectivity network whose nodes are optimized on the basis of the clustering results. CPDC can detect even short-lived (e.g. 20 seconds) coherent clusters. We identify a network of correlated activity involving areas in the visual cortex, the parietal cortex, the precuneus, and the prefrontal cortex. For subjects following the instructed strategy, incremental learning was reflected into a progressive strengthening of several network links, which paralleled a reduction in response times. In the sudden passage from the spatial to the color strategy, we observed a weakening of some network links, including those that previously showed the strongest strengthening. Our results contribute to the current debate on network neuroscience and learning (Mattar and Bassett, arXiv:1609.01790).

CDPC proved to be highly effective for tracking network dynamics and may be fruitfully applied to other tasks.

## **A44. The importance of executive functions to effectiveness of peer tutoring**

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**Keywords:** Executive functions, Peer tutoring, Planning skills, Cognitive flexibility

Teaching others effectively may rely on level of tutor's executive functions (Davis- Unger & Carlson, 2008). Executive functions are also important for children academic achievements (Brocka *et al.*, 2009). The aim of this research was to explore the role of executive functions (EF) in effectiveness of peer tutoring. Six years old children (N = 200) solved tasks measures four components of executive functions: inhibitory control, planning, cognitive flexibility and working memory. Children were divided into groups of high, medium or low level of EF. Next children were randomly paired in dyad on the same or different level of EF. Tutors were asked to teach peer how to play a new board game. Two weeks after peer tutoring students were asked to recall game rules. Two competent judges were encoding tutor and student's strategies during peer tutoring. Results show that student's level of development of EF, especially planning skills and cognitive flexibility correlates with number of recalled game rules. Students in dyad with the same high level of EF and in dyad where tutor had higher level of EF than student recalled most game rules. Students in dyad where student had higher level of EF than tutor recalled more rules than students in dyad with the same medium or low level of EF. The executive functions, especially planning skills and cognitive flexibility are important for effectiveness of peer tutoring. The level of children's EF in dyad is important for peer tutoring.

## **A45. Cross-frequency coupling: an application of modulation theory to electrophysiology**

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Keywords: Cross-frequency coupling, Modulation theory, Electrophysiology, Theta, Gamma

Cross-frequency coupling (CFC) generally labels the interactions between two signals at different frequencies. In electrophysiology, empirical evidences revealed the presence of coupling between low- ( $\delta$  or  $\theta$ ) and high- ( $\beta$  or  $\gamma$ ) frequency oscillations, which provided a novel perspective for characterizing and understanding executive functions. Several methods have been employed to quantify this phenomenon in different kinds of electrophysiological signals. Unfortunately, several parameters had to be determined (e.g. the frequency/bandwidth of the two components interacting in the CFC) and their selection is often data-driven. This contribution aims at translating the well-known theoretical framework about signal modulation from its original field of telecommunication engineering to the study of CFC. Thanks to this approach, it is possible to limit the range of the most important parameters in order to ensure a proper coupling. Thus, this work provides a platform to (i) simulate an expected strength of CFC, (ii) test the effectiveness of any other method of quantification of CFC and (iii) optimally decode the neural code, i.e., the components of an electrophysiological signal with CFC, underlying specific executive functions. This contribution will support the study of executive functions (especially working memory, attention, decision-making and perception) where CFC has been found to reflect their periodic nature and inter-networks communications have been suggested to exploit CFC mechanisms to communicate among different areas during perception and cognition.

## **A46. Influence of consciously versus unconsciously perceived reward on the recruitment of proactive and reactive modes of control**

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Keywords: Proactive and reactive modes of control, Motivation, ERP

When people expect a reward, such as money, they tend to perform better whether or not they are consciously aware of its value. Even if consciously versus unconsciously perceived rewards may influence performance similarly, their effects are underpinned by distinct neural networks (Bijleveld et al, 2012), and may differ in terms of their time course activation. The main aim of the present study is to identify similarities and differences regarding how consciously and unconsciously perceived rewards impact the recruitment of the proactive and reactive modes of control. Indeed, according to the Dual Mechanisms of Control framework (Braver et al, 2012), cognitive control can be recruited either in an anticipatory mode, to maintain goal-relevant information in a sustained manner (the proactive mode), or in a transient mode, to temporarily reactivate task goals after the occurrence of a crucial event (the reactive mode). To that end, we used a rewarded AX-CPT task combined with event related potentials (ERP) recordings. At the beginning of each run, participants were exposed to a high-value or a low-value coin presented subliminally on half of the trials. Participants were told that they could earn the monetary value by responding quickly and accurately. Our preliminary results reveal different influences of consciously and unconsciously perceived rewards on the recruitment of these two modes of control. This work should help us to progress in our understanding of the role of consciousness in reward pursuit, and may potentially lead to new studies especially in the field of psychopathology.

## **A47. The role of superior parietal cortex in the attention to delayed intention**

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**Keywords:** Prospective memory, Intentions, Superior parietal cortex, TMS, Attention, Top-down, Bottom-up, Monitoring

The ability to remember to carry out an intention when the appropriate cue occurs is typically referred to as Prospective Memory (PM). This study was aimed at investigating whether the superior parietal cortex is causally involved in PM and, if so, what is its functional role. We applied repetitive transcranial magnetic stimulation (rTMS) to the left and right superior parietal cortex, and we evaluated the TMS effects on two PM tasks that differed for the type of attentional load. The ‘Monitoring-load’ task required to direct the attention towards the external stimuli whereas the ‘Retrospective-load’ task required to direct the attention internally, towards the intention in memory (‘Retrospective-load’ task). rTMS of left parietal cortex produced a facilitation of PM performance in both tasks. This was coupled by slower responses to the ongoing activity, for left and right parietal stimulation, but selectively in the ‘Retrospective-load’ condition. The present findings suggest that superior parietal cortex is causally involved in biasing top-down attentional resources between the external, ongoing stimuli and the internal, PM intentions. The possible physiological mechanisms underlying the TMS-related improvement in PM performance are discussed.

## A48. Finding archetypes in human cognition and behavior by using Pareto Optimality

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**Keywords:** Pareto Optimality theory, Human Connectome Project, Reward system Cognition, Delay Discounting Task

When organisms need to perform multiple tasks, they face fundamental tradeoffs. According to Pareto optimality theory, such tradeoffs lead to phenotypes distributed on polygons in the traits space, where the vertices – called archetypes – represent the specialists at one of the tasks. We applied this theory to identify possible tradeoffs across distinct abilities and styles of human cognition and behavior. We analyzed data of 919 individuals from the Human Connectome Project, taking into account measures related to cognitive and personality traits. Of all the measures across multiple domains, we found significant fit to Pareto optimality only in one task associated with the Delay Discounting Task (DDT). Specifically, individuals fell within a triangle in the phenotype space, where the vertices of the triangle suggest three archetypal reward approaches. One vertex identifies individuals with greater preference for smaller, more immediate rewards at the expense of larger but delayed rewards. The second vertex identifies individuals with stable preference for larger rewards, even if delayed. The third vertex identifies a mixed approach, characterized by tendency to prefer delayed reward only if the amount is very large. The enrichment analyses highlighted that differences in the reward approach observed in the DDT are associated with differences in cognitive abilities (e.g., intelligence), personality traits (e.g., agreeableness), habits (e.g., smoking), and brain structures (e.g., gray matter volume). These results support Pareto optimality theory as a method to investigate evolutionary tradeoffs, and suggest that the reward approach is a putative trait that shapes the natural selection of phenotypes.

## **A49. Modulation of the action self-monitoring: a Transcranial Magnetic Stimulation study in the healthy brain**

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Keywords: Motor Awareness, Premotor Cortex, TMS

Previous studies on the conscious/unconscious mechanisms underlying the construction of willed actions reported that the Premotor (PMC) and Parietal Cortex are involved in action monitoring (Berti *et al.*, 2005; Desmurget *et al.*, 2009), although their precise role in the construction of motor awareness (MA) is still under investigation. In the present study, we evaluated the role of the PMC in MA in thirteen healthy participants using low-frequency rTMS. We used a motor task in which subjects had to trace straight lines to a given target with the right and the left hand. Participants received a visual feedback on a computer screen. In 96% of the trials, the line trajectories shown on the screen were deviated to the right or to the left by a variable angle. Therefore, in order to trace straight trajectories, the subject had to deviate in the opposite direction. At the end of each trial, participants were asked to report if the line they saw on the computer screen was the line they actually traced. There were three conditions: I) baseline; II) rTMS, after 1Hz rTMS (900 pulses at 90% of rMT) over the right PMC; III) sham. Results show that in the baseline condition participants did not recognize the deviation until a certain degree of angle. Importantly, active, but not sham, rTMS significantly modulated MA, decreasing the amplitude of the angle at which participants became aware of the correction of their trajectory. These results indicate that the PMC may play a crucial role in action self- monitoring.

## **A50. Functional heterogeneity in the dorsal and medial premotor cortex during motor preparation revealed by transcranial magnetic stimulation (TMS) mapping**

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Keywords: Premotor cortex, Motor preparation, Motor inhibition, Motor timing

The dorsal premotor cortex (PMd or dorsolateral Brodmann's area 6) in humans is a large cortical region exceeding 20 cm<sup>2</sup> in surface. It plays a pivotal role connecting the prefrontal regions with the motor cortex, transforming executive control into commitment to action. In spite of extensive knowledge on the topography of the PMd region in monkeys, little is known on its parcellation and functional specialization in humans. Here we perform a systematic mapping of the PMd region by means of event-related TMS while participants performed a reaction time task requiring an instructed response to a GO-signal presented after a fixed, predictable SET-period. The response consisted in a button press with the protruded lips. Single transcranial magnetic stimulation (TMS) pulses preceded in every trial the GO-signal by an interval varying between 200 and 10 ms. TMS was applied over 18 different scalp positions, changing in every trial. The grid of TMS target was arranged to cover the whole of the PMd in both hemispheres, including the midline regions. The results indicated a clear spatial distribution of the effects of TMS on motor performance. Stimulation of a large caudal region spreading from the convexity to the medial surface produced shortened response times and increased anticipation errors. Stimulation of a smaller rostro-medial region increased reaction times and delay errors. The present data indicate that the dorsal premotor complex is functionally heterogeneous. Perturbation of different PMd components during a predictable SET- period impairs in opposite ways the timing of responses to the upcoming GO-signal.



## A51. The neural basis of free language choice in bilingual speakers

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**Keywords:** Bilingualism, Language, Time resolved fMRI, Cognitive control, Speech, Intention, Lexicon, Naming

Bilinguals have the ability to switch between languages with apparent ease. Indeed, language switching is an integral aspect and unique to bilingualism. Language control functions must guarantee the choice of the context-relevant language and protection from interferences from the non-relevant language. Several neuroimaging studies report that language control is achieved through a network tightly related general executive control. Critically, however, those studies are based almost exclusively on experimental paradigms that do not allow subjects to choose language freely, as it occurs in daily life. Furthermore, most studies collapse different components of language control like language choice and language execution. To fill these gaps, we had German-English bilinguals freely choose in which language to name pictures, while their brain activity was monitored by MRI. Language choice/maintenance and language execution were temporally separated by a delay. By applying Multivariate Pattern Analysis (MVPA) we found that during the language choice/maintenance phase language choice was represented in the medial prefrontal cortex (BA10, BA32), a region known to be involved in freely choosing between alternatives, and not necessarily related to language. By contrast, during language execution both MVPA and univariate analyses identified a network of brain regions compatible with the so-called “language control network”, including basal ganglia, the left inferior frontal gyrus and the left temporal lobe. Our findings strongly argue for an involve-

ment of general domain executive mechanisms during language choice in bilinguals and clearly distinguish brain regions involved in language choice and language execution.

## **A52. The Influence of Executive Function on Prosodic Performance**

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Keywords: Autism, Executive Function, Prosody

Few studies explore the relation between the performance on prosodic tests and executive function skills. Our goal is to understand how executive functions are related to prosodic performance in a clinic population. As executive impairments and prosodic deficits are characteristic of autism, we analysed a group of 15 children (12 boys) with high-functioning autism (HFA; 6 - 9 years of age,  $M = 7.40$ ,  $SD = 1.12$ ;  $IQ \geq 70$ ) matched to typically developing peers on age, gender, and non-verbal intelligence ( $n = 15$ ). We used the Profiling Elements of Prosody in Speech- Communication (PEPS-C) to assess prosodic performance and the Children's Color Trails Test (CCTT) as an indicator of executive control abilities. For the PEPS-C the difference between groups was statistically significant:  $F(1, 28) = 6.659$ ,  $p = .015$ ;  $\eta^2 = .192$ . The analysis of the correlations between PEPS-C and performance in CCTT Part 1 and 2 for the clinical population was helpful to identify cognitive processes related to prosodic performance: no correlation was found between CCTT-1 and PEPS-C, but a strong correlation was found between the CCTT-2 and PEPS-C ( $r = .75$ ,  $p < .001$ ). Thus, findings for this clinical group show no relation between prosodic performance and the visual search and processing speed assessed by CCTT-1, but a significant and strong correlation between prosodic performance and working memory/sequencing, set-switching, and inhibiting the overlearned response to continue the sequence, skills assessed by CCTT-2. Further studies are needed to understand if impaired prosody is related to executive dysfunction.

## **A53. Identifying specific brain signatures of transitions between words**

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Keywords: Associative neuronal mechanisms, Latching dynamics, Language processing, EEG

Understanding the associative neuronal mechanisms which underlie language processing is challenging. To address this issue, we have developed a novel paradigm to distinguish among the brain signatures of different types of transitions between words. These have previously been hypothesised to reflect latching dynamics between discrete brain states. We have conducted two experiments, a behavioural, reaction times (RT) one, and a pilot ERP one. The design introduces 12 rounds of a computer game, each including 28 words, which latch onto one another through one of 7 types of transition: letter-addition, -omission, -change, anagram, antonym, synonym, semantic relation. The goal of the game is to find the one correct sequence, and move quickly to the next round. Behavioural results reveal variability in the mean RT among types of transitions while the pilot ERP study indicates different signatures for the two main classes of transitions – semantic and word-form one. The results suggest a difference in the processing of specific transition types, and are thus promising for our goal of relating distinct brain signatures to different associative mechanisms underlying semantic and word-form processing.

## **A54. How do we produce cognitive estimates? An investigation of healthy individuals performing the Cognitive Estimation Test**

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**Keywords:** Cognitive Estimation, Monitoring, Semantic Knowledge

The Cognitive Estimation Test (CET; Shallice & Evans, 1978; MacPherson *et al.*, 2014) is a commonly used assessment of executive dysfunction. The CET examines the ability to produce reasonable estimates in response to questions that individuals would not know that the exact answer to (e.g., “How long is the average man’s spine?”). The CET is thought to rely upon executive processes such as reasoning, the development and application of appropriate strategies and monitoring the response appropriateness. While executive functions are thought to be mediated primarily by the frontal lobes, our recent work suggests that only certain CET items are both sensitive and specific to frontal lobe lesions. Therefore, it is important to understand how individuals produce cognitive estimates and whether specific methods of generating estimates might be better at producing appropriate responses. Healthy adults (N = 186, age = 18-85 years) performed online versions of the CET-A and CET- B (MacPherson *et al.*, 2014), providing cognitive estimate responses, and the methods used to generate these cognitive estimates and confidence ratings. Binary logistic regression including age group, response method and confidence ratings as explanatory variables revealed that participants who rely on their general knowledge to answer items are less likely to produce extreme CET responses. Moreover, the higher a participant’s confidence in their estimate, the less likely a CET response will be extreme. While

the CET is considered an assessment of executive function, these findings demonstrate that better semantic knowledge, rather than strategy use, results in better CET performance, at least in healthy individuals.

## **A55. Moral Judgment and altruistic/deontological guilt**

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Keywords: Moral dilemma, Altruistic guilt, Deontological guilt

People often make complicated decisions to help or to punish perfect strangers. To harm someone or broken some moral imperative is usually linked to feeling guilt, and several researches suggested the existence of two different kinds of guilt: altruistic and deontological. Our study aimed at investigating the decision-making processes in moral judgment (where the decision does harm other people) under different conditions of guilt: Standard (SM; without any influence), Altruistic (AM; where the decision has made while physically close to the potential victims) and Deontological (DM; where the decision has made while flanked by an 'authority'). A fourth group served as control group and was asked to answer to Non Moral dilemmas (NM, where the protagonist's choice does not cause any harm). We enrolled 120 healthy subjects (69 females). We observed a higher number of utilitarian/positive responses when individuals had to respond to AM, with respect to DM and NM dilemmas. Moreover, looking at the time needed to read the dilemma, under altruistic guilt condition people tended to be slower in reading the dilemmas than in other conditions and this both in case of positive and negative responses. No significant differences in time needed to effectively respond emerged. This findings suggested that be physically close to potential victims or be flanked by an 'authority' differentially influence the

decision-making processes in moral judgment, inducing slower decisions and more utilitarian answers, particularly in the scenario of physical proximity.

## **A56. Computer games decrease proactive control: the role of context**

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Keywords: Proactive control, Games users, Game context

There are more and more people using computer games. Previous studies have indicated that action computer games support various types of cognitive functions. However, other studies show that the video game experience may have a negative influence on proactive cognitive control. According to the Dual Mechanism of Control theory, context is an extremely important element that can modify cognitive control. Therefore, the aim of our study was to investigate the interaction between game experience and game context in proactive cognitive control. Our study comprised 70 subjects ( $M = 21,26$  years;  $SD = 2,92$ ) divided in three groups: action games users ( $N = 25$ ), other games users ( $N = 20$ ) and no gamers ( $N = 25$ ). Problematic game use was controlled. We used an AX-CPT paradigm and images from the Nencki Affective Picture System in neutral context and screenshots from the most frequently mentioned games in game context. Proactive control was drawn up as a Proactive Index, calculated separately for response times and the number of errors. As in previous studies, we observed the main effect of computer game experience. The action games users have lower proactive control than no gamers, however, we also observed main effect of context. Participants have lower cognitive control in game condition than in neutral condition. The most important result is the interaction between game experience and context. We demonstrated that game experience and context decrease proactive cognitive control. This study was supported from resources of the Gambling Problem Solving Fund, Ministry of Health, agreement no 91/HM/2015 and no 13/HMK/2016.

## **A57. The dorsomedial prefrontal cortex mediates the interaction between moral and aesthetic valuation: a TMS study on the Beauty-is-Good stereotype**

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**Keywords:** Transcranial Magnetic Stimulation, Dorsomedial Prefrontal Cortex, Aesthetic evaluation, Social stereotyping

Studies routinely suggest that attractive individuals are perceived as possessing more positive personal traits than unattractive individuals. This reliance on aesthetic features to infer moral character suggests a close link between aesthetic and moral valuation. Here we aimed to investigate the neural underpinnings of the interaction between aesthetic and moral valuation by combining transcranial magnetic stimulation (TMS) with a priming paradigm designed to assess the Beauty-is-Good stereotype. Participants evaluated the trustworthiness of a series of faces (targets), each of which was preceded by an adjective describing desirable, undesirable, or neutral aesthetic qualities (primes). TMS was applied between prime and target to interfere with activity in two regions known to be involved in aesthetic and moral valuation: the dorsomedial prefrontal cortex (dmPFC, a core region in social cognition) and the dorsolateral prefrontal cortex (dlPFC, critical in decision making). Our results showed that when TMS was applied over vertex (control) and over the dlPFC, participants judged faces as more trustworthy when preceded by positive than by negative aesthetic primes (as also shown in two behavioral experiments). However, when TMS was applied over the dmPFC, primes had no effect on trustworthiness judgments. A second Experiment corroborated this finding. Our results suggest that mPFC plays a causal role linking moral and aesthetic valuation.

## **A58. Proposal for a Cognitive Training on a group of dyslexic adolescents**

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**Keywords:** Executive System, Learning, Cognitive Training

It was hypothesized that a process enhancement program focusing on executive control, working memory, shifting and the inhibition of automatic responses could lead to better outcome in school attitudes in an experimental group of subjects than a control group who did not follow a Training program. Twenty-seven individuals (13 experimental, 14 controls, mean age: 13.6) with prior diagnosis of learning disabilities. To test the research hypothesis, we carried out an evaluation of school attitude as well as an investigation into the functioning of the Executive System. The administration was performed, for the experimental group, pre-intervention and post-intervention after 6 months of treatment. For the control group, the evaluation was performed at a diagnostic stage and then for a period of one year or more. Statistical analysis were performed on 26 subjects (13 experimental, 13 controls). Significant post-intervention differences were noted for the improvement of the experimental group only in the Five Point Test. Such an improvement was also expressed in reading (syllables/second). The participation to the training program contributed to the strengthening of the Executive-Attentive System on which the training was focused. The improvement that emerged in reading, without ever enhancing this ability, confirms that the working memory capacity is a transversal ability whose potentiation brings benefits also to school skills.



## **A59. Distinct patterns of functional connectivity of language, control, and default networks for aphasic deficits after stroke**

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**Keywords:** Stroke, Aphasia, Executive functions, Functional MRI, Resting state networks

Previous studies have identified distinct profiles of language impairments after stroke, in phonological processing, semantic, and executive-cognitive functions. Here we show that different constellations of language deficits are distinguished by the relative strengths of their association with the resting-state functional connectivity (FC) of the language (LN), cingulo-opercular (CON), and default mode (DMN) networks. In a group of left hemisphere damaged patients with acute stroke, we identified three clusters of deficits including semantic (comprehension/production), phonology, and verbal executive functions. To selectively relate a given behavior with the FC of a given network, we computed partial correlations in which the contributions of a behavioral cluster and network FC of no-interest were statistically removed. We observed two double dissociations linking abnormal FC patterns to language deficits: i. the phonological deficit was more correlated with lower FC of the LN within the left hemisphere than lower inter-hemispheric FC of the CON, whereas the executive deficit was more correlated with lower FC of the CON than the LN in the left hemisphere; ii. the phonological deficit was more correlated with lower FC of the LN within the left hemisphere than lower inter-hemispheric FC of the DMN, whereas the semantic deficit was more correlated with lower inter-hemispheric FC of the DMN than the LN in the left hemisphere. These findings indicate that after a left hemisphere lesion, the language network plays a more important role for phonological processing, while FC of cingulo-opercular and default mode networks is more relevant for verbal executive and semantic functions, respectively.

## A60. Changes in executive function across adulthood

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Keywords: Executive function, Ageing, Cognitive decline

Executive functions play an important role in our everyday life, allowing us to consider other people's perspectives, focus attention on specific tasks, and to engage in successful problem solving. Prior research has found that general executive functions may vary at different ages, with older age often characterised by a decline in executive functioning. The current study sought to explore whether these age-related declines reflect overall executive functioning deficits, or whether specific deficits in separable components of executive function can be seen at different ages. Participants aged 18-86 years-old completed a battery of executive function tasks assessing the specific roles of working memory (operation span), planning (Tower of Hanoi), cognitive flexibility (task-switching) and inhibitory control (Stroop). As expected, results revealed that inhibitory control declined throughout adulthood. Interestingly, working memory was found to be maintained across adulthood, until around the age of 60 years-old when a decline in working memory begins to emerge. Cognitive flexibility and planning abilities were found to be stable across adulthood, with no apparent declines in older age. Results suggest that the influence of age on executive function abilities is not an all-or-nothing capacity, with distinct performance across separable measures of executive function abilities. Older age is characterised by a decline in inhibitory control and working memory, but other components of executive function are maintained across the lifespan.

PART 5

**Abstracts: Poster Session B (30 Sept 2017)**

**B1. The effect of subthalamic nucleus deep brain stimulation on executive functions in Parkinson's disease**

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**Keywords:** Parkinson's disease, Deep brain stimulation, Executive function

The aim of the present study was to assess the effect of bilateral deep brain stimulation (DBS) of the subthalamic nucleus (STN) on executive functions in patients with Parkinson's disease (PD) using an unstimulated PD control group matched on motor symptoms, medication and DBS indication. Ten PD patients with DBS implantation (DBS group) and 10 PD wait-listed patients (control group) participated in the study. A neuropsychological battery was used to assess cognitive functions, including general mental ability (Mini Mental State Examination) and various executive functions. Each task was administered twice: before and after surgery in the DBS group with the stimulators on and with a similar time interval between the two task-administration points in the control group. There was no significant difference between the DBS and the control groups' performance in tasks measuring updating of verbal, spatial and visual information (Digit Span Task, Corsi Block Tapping Task, N-back Task), planning and shifting (Trail Making Task - B) and conflict resolution (Stroop Task). The DBS group showed a significant decline only on the semantic verbal fluency task after surgery compared to its own

baseline level ( $p < .05$ ), which is in line with findings of previous studies. Our results provide support for the cognitive safety of the STN DBS using a wait-listed PD control group.

## **B2. Computerized versus paper-and-pencil tests: an exploratory study on Parkinson's patients**

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**Keywords:** Parkinson's disease, Computerized tests, Inhibition, Cognitive flexibility, Psychomotor speed

In Parkinson's disease (PD), cognitive alterations could be present at time of diagnosis, affecting patients and caregivers wellbeing. In particular driving ability is one of the most important daily functional activities in term of autonomy maintenance and good quality of life. Thus the focus of this study is to verify the sensitivity of a computerised test in evaluating PD cognitive skills, mainly involved in driving as compared to paper-and-pencil tests. The computer-based battery DRIVESC (Vienna Test System) was used: namely, frontal-striatal based tests (attention and working memory, psychomotor speed, inhibition and cognitive flexibility, visuo-spatial recognition). Moreover, three paper-and-pencil tests were chosen (Stroop Test, Entangled figures, Trail Making Test A and B) as matching the cognitive dimensions evaluated by DRIVESC. Both DRIVESC and paper-and-pencil tests were administered to nine non-demented PD and nine healthy controls. Results showed a significant group (Wald  $X^2(1) = 17.38$ ;  $p < .0001$ ) and type of test effect (Wald  $X^2(1) = 6.23$ ;  $p = .013$ ). PD patients turned out to have a significantly worse performance than controls in both DRIVESC (DIFFM = 7.94;  $p = .012$ ) and paper-and-pencil tests (DIFFM = 11.33;  $p < .0001$ ) particularly in the area of inhibition and cognitive flexibility. Lastly, PD patients had a worse performance (DIFFM = 13.89;  $p = .002$ ) in the computerised test compared to the

paper-and-pencil tests in the area of psychomotor speed. DRIVESC seems to be able to detect deficits in the following domains: inhibition/cognitive flexibility and psychomotor speed. These results are promising especially for the practical use of this computerized test in the evaluation of driving abilities, a worth field of application for PD patients.

### **B3. Brain connectivity changes associated with tDCS plus cognitive training in Parkinson's disease with mild cognitive impairment**

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Keywords: Parkinson, tDCS, Training

The aim of this study was to investigate whether cognitive changes are associated with regional modifications of brain perfusion and cortical excitability in Parkinson. In a double-blind randomized study, twenty matched Parkinson's patients with mild cognitive impairment underwent a treatment consisted of anodal transcranial direct current stimulation (tDCS) of left-DLPFC (10 real and 10 sham) during a structured 30-minute cognitive training for 4 weeks. Cognitive and MRI data were collected after treatment and at 16-week. At 4-week, real-tDCS group showed increased fractional amplitude of low frequency fluctuation (fALFF) activity in bilateral frontal areas, right temporal, left cerebellum and decreased activity in left precen-tral, temporal and right fronto-orbital areas, together with decreased performance in attentional and motor speed abilities. At 16-week, we observed a wider increase of fALFF activity in parieto-temporal regions, cerebellum and focal reduction in the frontal middle, orbital areas bilaterally and right cerebellum, together with increased performance in visuo-spatial abilities and

long-term memory. At 4-week the sham- group showed a broad increase in whole brain activity and focal decreased in temporal, angular, cerebellum areas, together with increased long-term memory. At 16-week a brain activity similar to baseline was observed with reduced activity in frontal, rolandic, cingulate, cerebellum areas and focal increase in occipito- temporal areas, together with a cognitive performance similar to baseline. We found brain connectivity modifications associated with cognitive changes both at 4-week and follow-up. These results are promising and should help clarifying how the brain is endowed with intrinsic functional reorganization to support cognitive changes over time.

## **B4. Cognitive profiling in patients with Parkinson's disease, multiple system atrophy and progressive supranuclear palsy: a 15-month longitudinal study**

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**Keywords:** Parkinson, Progressive supranuclear palsy, Multiple system atrophy, Cognitive Decline

The aim of this study was to characterize the progression of cognitive decline and compare the neuropsychological 15-month profile across progressive supranuclear palsy (PSP), multiple system atrophy (MSA) and Parkinson's disease (PD). Cognitive impairments are frequently reported in these parkinsonian disorders. However rate of cognitive decline is still unclear. This longitudinal study consisted of 40 patients (10 MSA, 10 PSP and 20 age, education and disease duration matched-PD), who underwent an extensive neuropsychological and clinical assessment. Daily functioning (ADL/IADL), global cognitive status (MMSE, MoCA) and performance in five cognitive

domains were investigated. Each patient was re-tested at a mean of 15-month follow-up. At follow-up both MSA and PSP showed increased motor severity and reduced daily functioning. From a cognitive perspective, PSP had a decline in the TMT-A and in the delayed story, MSA group's performance worsened in the MMSE, TMT-B, semantic fluencies and incomplete letter recognition tasks. Finally, PD patients showed reduced ADL, poorer performance in the copy of a complex figure and TMT-A. Overall we observed specific patterns of cognitive decline across groups. Namely, PSP showed attentive and memory deficits whereas MSA and PD patients cognitively declined in attention/executive and visuospatial tasks. Noteworthy, at baseline MoCA total score was significantly lower than MMSE for each group and in the MSA group, MMSE score decreased significantly at the follow-up compared to MoCA. These findings confirm MoCA as better cognitive screening scale vs. MMSE and may support the concept of MMSE as more sensitive to identify rate of cognitive decline.

## **B5. Intrinsic Network abnormalities associated with Parkinson's Disease: a focus on attention mechanisms**

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**Keywords:** Neurological Disorders, Parkinson, fMRI-Functional Connectivity, Resting state, Attention

Studies of Resting State functional MRI connectivity (fMRI-FC) in Parkinson's Disease (PD) consistently reported a FC decrease in the Default Mode (DM) and in the motor networks. Although attention disorders are fundamental among the non-motor symptoms of PD, investigations of their neural correlates are limited. To test the hypothesis that attention might be early impaired in PD we evaluated fMRI-FC of the dorsal (DAN), ventral,

executive attention and DM networks on three groups of volunteers (PD patients with Dementia, PDD; PD patients with spared cognition, PD- CNT; and Healthy Control, HC). After networks identifications, graph theory metrics were compared among the groups to identify possible differences in networks topology. DAN-posterior intraparietal sulcus (pIPS) was characterized bilaterally by higher number of links as a function of PD stages, with severity being associated with significant increase of node degree (PDD>P-DCNT>HC). In the same regions, PD also showed an increase in both local clustering and path length, suggesting an imbalance between segregated and integrated states. At the DMN level, higher number of links was found in PD patients than HC in the Angular Gyrus (AG) bilaterally and a decrease of links in the middle prefrontal cortex (mPFC). As for the pIPS, AG showed both higher values for local and distant connections in the PD groups as compared to HC. PD, even at early stages, showed abnormal fMRI-FC in the well-studied DMN but also in DAN as reflected by changes in the number of connections, as well as in characteristics of the functional connectome.

## **B6. When fruits lose to animals: disorganized search in semantic memory by Parkinson's Disease patients**

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**Keywords:** Parkinson's Disease, Semantic fluency task, Neuropsychological assessment, Executive function, Semantic category size

In order to cope successfully with our environment, we often need to effectively extract information from our semantic memory. The semantic fluency task is widely used in both clinical and research setting to investigate this ability, exploring both the integrity of the semantic store and the effec-



tiveness of search processes through it. Patients affected by Parkinson's Disease (PD) often fail on semantic fluency, although experimental findings are controversial and the underlying causes of this impairment are still debated. We compared 74 non-demented PD patients with 254 healthy subjects in a semantic fluency test using relatively small ("fruits") and large semantic categories ("animals"). PD patients' sequences were less semantically organised and included fewer subcategories than those of controls, pointing to a lack of strategy in exploring the semantic store. Interestingly, the strategy deficit emerged only in the smaller category ("fruits"), possibly because it has less and more narrow subcategories so that the retrieval requires a more taxing strategic exploration, particularly considering that only 1 minute is available. Our results suggest that the semantic fluency deficit in PD patients has a clear strategic component, even though that may not be the only cause of the impaired performance. Furthermore they suggest that the semantic category used in the test influences the performance, hence providing an explanation for the failure by previous studies, which often used large categories as "animals", to detect strategy deficits in PD.

## **B7. Trait impulsivity and response-inhibition in Parkinson Disease. An fMRI piloting study**

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**Keywords:** Parkinson Disease, Impulsive Control Disorder, Response-Inhibition fMRI

Dopamine-agonists have been implicated in Impulsive Control Disorder development since they can induce alterations in the frontostriatal network that manages reward and mediate impulse monitoring and control. It is possible to consider impulsivity by both motivational/affectively charged pro-

cesses and by the inhibition of ongoing or prepotent motor responses. The aim the study was to explore the response-inhibition performance and the neural correlates of inhibition in Parkinson Disease (PD) patients that varied on self-reported trait impulsivity. Ten cognitively non-impaired PD patients were recruited. They underwent a standard clinical assessment. The Barratt Impulsiveness Scale [BIS- 11] provided an integrated measure of trait-impulsivity. During an fMRI acquisition, each subject was asked to perform a GO-NOGO task. Associations between BOLD response during this task and trait impulsivity were investigated. In the contrast NOGO/GO activations were maximal in anterior cingulate cortex ( $x = 5.4$ ;  $y = 20$ ;  $z = 50$ ), threshold of  $p < .001$  uncorrected. Patients with greater scores on BIS-11 had greater activation of the bilateral supplementary motor area, bilateral anterior insula, bilateral anterior cingulate cortex, and right temporal parietal junction during response-inhibition. Moreover, a significant association between higher impulsivity scores and worse performance exists ( $p = .038$ ). Our results suggest that deficit in inhibitory processes may affect everyday life, causing impulsive conduct which is generally detrimental for PD patients. The association between BIS-11 scores, MPFC, SMA and TPJ suggests that greater engagement of this network was needed to maintain behavioral inhibition in more impulsive PD patients. Indeed, neuroimaging of brain activity during GO-NOGO task may be useful in characterizing the patients' clinical profile.

## B8. Interpreting Humorous Cartoons in Parkinson's disease

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Keywords: Parkinson's Disease, Humor, Cognitive Reserve, Pragmatics

Perception and appreciation of humor are dependent both on intact cognitive functions: logic, attention, working memory, mental flexibility and verbal abstraction, all of which have been proven impaired in Parkinson's disease (PD). The present study investigated appreciation of humorous content in both PD patients and healthy controls. 20 PD patients and 40 healthy controls (20 age matched with PD subjects, and 20 students) were enrolled in

the study. All subjects firstly underwent neuropsychological testing (MoCA, MMSE and ENPA within normal range) and the Cognitive Reserve Index Questionnaire (CRI-Q). During the experimental session, appreciation of three types of sentence (coherent-obvious, non-sense, humorous/target) written under 10 humorous cartoons were assessed. In the task, subjects were required to decide which sentence was more humorous in relation to the content of the cartoon. In PD sample, negative correlation has been observed between age and humorous sentence identification while a positive correlation resulted between MMSE and MoCA scores and humorous target. Furthermore, in PD subjects we found negative correlation between scores at “working activity”, and “leisure time” of the CRI-Q and tendency to choose coherent-obvious sentence, while the elderly group showed a positive correlation between choose of humorous sentences and “education” and “working activity” scores at the CRI-Q. The present study suggests the role of the Cognitive Reserve in managing cognitive task in PD such as interpreting humorous contents, where the contribution of the past leisure and working activities may be most accessible source of information in solving pragmatics and linguistic tasks.

## **B9. Neuroanatomical Underpinnings of Executive Set-switching Deficits in Acute Stroke Survivors**

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Keywords: Voxelwise lesion-symptom mapping, Task-switching, TMT, Stroke

Executive control involves the ability to flexibly switch attention between different stimulus properties or sets. While executive set-switching deficits have been repeatedly documented in stroke survivors, only a few studies attempted to map the neuroanatomical underpinnings in a voxelwise fashion. In the current study, we collected behavioural ( $5 \pm 4$  days) and brain-imaging data ( $2 \pm 3$  days) in a large and neglect-free cohort of acute stroke survivors

(N = 144) to test for voxelwise associations between localised brain damage and executive deficits. Executive set-switching was evaluated using the Trail Making Task (TMT) of the Oxford Cognitive Screen (Demeyere *et al.*, 2015, Psychological Assessment). This TMT variant is optimized for detecting executive dysfunctions in stroke survivors by using stimulus sets that minimize numeracy and language processing demands. Raw scores reflecting TMT set-switching accuracy were combined with manually delineated lesions for the voxelwise lesion-symptom mapping analysis (VLSM, threshold  $p < 0.001$ , based on the cluster size and permutation method). The VLSM results showed that structural lesions of the left insular cortex extending into pre-central gyrus predicted lower set-switching accuracy, even after correcting for low-level visuo-spatial and motor components of the TMT. The current study extends the findings from previous VLSM research by demonstrating an involvement of the left insular cortex in mediating higher-order executive-control behaviour in the acute phase of stroke.

## **B10. Lesion Neuroanatomy of Post Stroke Deficits in Selective Auditory Attention**

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**Keywords:** Stroke, VLSM, Selective Attention, White Matter, Auditory Attention Task

The ability to selectively attend to goal relevant information in order to guide and modulate behaviour is a subtle but essential skill required in daily tasks. For patients who are experiencing associated deficits, everyday life can become challenging and disorganised. In this study we aimed to explore lesions sites associated with impairments in selective attention in a sample of 334 subacute stroke patients (~3 months post stroke). A voxel-based lesion-symptom mapping approach was utilised to examine the relationship

between lesion location and selective attention performance (as measured by the Auditory Attention Task). Additionally, the extent of damage within white matter tracts was calculated and regression analysis run to examine the relationship between connectivity and task performance. It was found that lesions within the multiple demands (MD) network (e.g. inferior frontal gyrus, middle frontal gyrus, insula) or modality specific regions (e.g. middle temporal gyrus) were associated with impaired selective attention performance. In addition, damage to white matter connecting MD regions (e.g. fronto-insular tracts) or connecting MD regions to modality specific regions (e.g. superior longitudinal fasciculus III) was associated with impaired selective attention. The results suggest that impaired auditory selective attention is associated with damage to regions requiring controlled attention to guide goal directed behavior.

## **B11. Executive functioning in relapsing-remitting multiple sclerosis patients without cognitive impairment: a task switching protocol**

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**Keywords:** Task switching, Information processing speed, Multiple sclerosis

**Background:** Cognitive dysfunction affects 40%–65% of MS patients, most often affecting information processing speed and working memory me-

diated by the pre-frontal cortex (PFC). Objective: Our study aimed to investigate PFC functioning through a task-switching protocol in relapsing-remitting MS patients without cognitive impairment. Methods: Twenty-four patients and 25 controls were enrolled. Two different tasks were performed in rapid and random succession, so that the task was either changed from one trial to the next one (switch trials) or repeated (repetition trials). Switch trials are usually slower than repetitions, causing a so called 'switch cost' (SC). Results: Patients had worse performance than controls only in the switch trials, as indicated by the increased SC, reaction times and error proportion. Moreover, patients showed a reduced ability to reconfigure the task-set for the execution of a new task and to disengage from the previous task. Conclusions: Our results showed a primary deficit in executive control processes involved in the task-switching performance in relapsing-remitting MS patients without cognitive impairment. This deficit may depend on the functional impairment of the PFC, which is essential to adjust behaviour rapidly and flexibly in response to environmental changes, representing one of the most sophisticated human abilities.

## **B12. Exploring executive functions in Multiple Sclerosis**

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**Keywords:** Multiple Sclerosis, Executive functions, Neuropsychological assessment, Delis-Kaplan Executive Function System Sorting Test, Brief Repeatable Battery of Neuropsychological Test

**Background and Objectives.** The Brief Repeatable Battery of Neuropsychological Test (BRB-NT) does not explore the executive functions. We combined BRB-NT and Delis- Kaplan Executive Function System Sorting Test (D-KEFS ST) to obtain a more comprehensive evaluation of cognitive impairment in Multiple Sclerosis (MS) patients. **Methods.** 59 Clinically Iso-

lated Syndrome or early onset Relapsing Remitting MS (CIS/eRRMS) and 78 Relapsing Remitting MS (RRMS) patients underwent a detailed neuropsychological assessment including BRB-NT, D-KEFS ST and self-administrated questionnaires, namely the Multiple Sclerosis Neuropsychological Questionnaire (MSNQ), the Fatigue Severity Scale (FSS) and the Beck Depression Inventory-Second Edition (BDI-II). Results. The only test of BRB-NT that correlated, although mildly, with D-KEFS ST was Symbol Digit Modalities Test ( $r = 0.5$ ,  $p < 0.001$ ). Non-linear regression analysis disclosed that the failure in D-KEFS ST was strongly predicted by the number of failed BRB-NT items ( $r^2 = 0.98$ ). MS patients failing in D-KEFS ST, but not in BRB-NT, presented higher MSNQ values. Conclusions. Considering the lack of strong correlations between BRB-NT and D-KEFS ST items, these two batteries should be considered as complementary in the clinical evaluation of MS patients. Their combination may help clinicians to identify a subgroup of MS patients having executive dysfunctions and a more severe cognitive decline. Since impaired executive functions may hamper patient's quality of life and reduce therapeutic compliance, D-KEFS ST inclusion in the routine assessment of cognition in MS patients should be considered.

### **B13. Executive functioning may affect verbal learning and recall in multiple sclerosis patients: a combined behavioral and magnetic resonance study**

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Keywords: Multiple sclerosis, Executive functions, Learning and memory, Magnetic resonance imaging

Cognitive impairment, especially learning and memory, is frequent in multiple sclerosis (MS) patients (Chiaravalloti & DeLuca, 2008). Learning and memory are complex cognitive processes linked to executive functioning (Stuss *et al.*, 1994). However, there is still disagreement over the nature of MS-related memory impairment: some authors argued for deficits in retrieval process (Bobholz *et al.*, 2006; Rao *et al.*, 1993), while others argued for

deficits in initial learning (DeLuca *et al.*, 1994; Thornton *et al.*, 2002). We assessed 137 consecutive MS patients (Polman *et al.*, 2011; age:  $39.9 \pm 10.4$ ; education:  $13.8 \pm 3.4$ ;  $F = 103$ ). Verbal learning and recall was assessed with the Selective Reminding Test (SRT), immediate (SRT-I) and delayed (SRT-D) recall. Structural 3Tesla magnetic resonance imaging (MRI) scans were available for all patients. Multiple regression analyses with stepwise method were used. We found that time interference of the Stroop test predicted the SRT-I ( $\beta = -.671$ ,  $t(81) = -3.028$ ,  $p = .003$ ), as well as the Phonemic verbal fluency (PhVF) test ( $\beta = .313$ ,  $t(81) = 2.446$ ,  $p = .017$ ). Moreover, the SRT-I predicted the SRT-D ( $\beta = .127$ ,  $t(81) = 12.036$ ,  $p < .001$ ), as well as the PhVF ( $\beta = .034$ ,  $t(81) = 2.305$ ,  $p = .024$ ). Volumetric analysis of MRI showed that the volume of the left superior frontal gyrus medial segment (ISFGms) predicted the SRT-I ( $\beta = 4791.612$ ,  $t(130) = 4.010$ ,  $p < .001$ ), as well as the volume of the left precentral gyrus (IPCG) ( $\beta = 1450.763$ ,  $t(130) = 2.461$ ,  $p = .015$ ). The relation between behavioral and MRI data suggests that learning deficits due to executive functioning may represent the core memory deficit in MS patients, supporting the learning-deficit hypothesis. The understanding of these processes can foster better cognitive rehabilitation interventions.

## **B14. Executive Functioning in Children with Attention-Deficit/Hyperactivity Disorder: Cognitive and Affective Aspects**

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**Keywords:** Attention-Deficit/Hyperactivity Disorder, Executive Functions, Cognitive and Affective Aspects of Executive Functions

Traditionally, research on Executive Functions (EF) has focused on cool cognitive aspects. More recently, definitions of EF make the distinction be-



tween cool cognitive aspects and hot affective aspects seen in situations that are emotionally and motivationally significant. This distinction allows a broader conception of EF that has potential to highlight the role of EF in clinical disorders. As several theoretical explanations of Attention Deficit/Hyperactivity Disorder (ADHD) have focused on EF as the main explanatory domain for the disorder, in this study, cognitive and affective aspects of EF were assessed in 6- to 10-year-olds ( $M = 8.4$  years,  $SD = 1.28$ ,  $n = 13$ ) with this condition. All ADHD - combined type participants were diagnosed based on DSM-IV criteria and were matched to typically developing peers on age, schooling, gender, and socioeconomic level ( $n = 16$ ). Working memory, mental flexibility, inhibition, planning, problem solving, and affective decision-making were assessed using the following measures: Digit Span, Verbal Fluency, Tower of London, Trail Making Test, Children's Color Trails Test, Behavior Rating Inventory of Executive Function, and Delay of Gratification Task (DGT). ADHD children performed significantly poorly in all EF tasks than typically developing peers. The difference was larger for hot EF assessed by DGT ( $M = 1.85$  vs.  $6.81$  number of times the reward was delayed in a total of 9 trials). The centrality of the EF deficit in ADHD, as well as the complex interactions between cognitive and affective aspects of EF in ADHD, should be explored.

## **B15. Contribution of the INECO Frontal Screening (IFS) to the differential diagnosis of healthy aging, Mild Cognitive Impairment and Alzheimer's disease**

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Keywords: Executive deficits, INECO Frontal Screening (IFS), Healthy aging, Mild Cognitive Impairment, Alzheimer's Disease

Executive Functions (EFs) are differently compromised in healthy aging, Mild Cognitive Impairment (MCI) and Alzheimer's Disease (AD), and their evaluation is important for differential diagnosis. The INECO Frontal

Screening (IFS) is a brief neuropsychological screening tool developed to assess executive dysfunction in neurodegenerative conditions. Goals: We aimed to examine IFS discriminative power by comparing the performance of healthy older participants, MCI and mild AD patients. We also explored the influence of age, years of education, and global cognition (Montreal Cognitive Assessment) on IFS performance. Method: IFS total scores were compared between 23 healthy older participants, 42 MCI and 23 mild AD patients. The three groups were matched for age and education. The Area Under the Curve (AUC) was analyzed and optimal cut-offs were determined. Results: Higher global cognition and education predicted higher IFS scores. Healthy participants had higher IFS scores than MCI and AD patients. IFS showed excellent diagnostic accuracy (AUC = .94 and .97,  $p < .001$ ), and a cut-off of 20.5 showed a sensitivity of 100% and specificity of 89.2% between healthy older participants and patients. However, after accounting for education, MCI and AD patients performed similarly on the IFS. Conclusion: To our knowledge, this is the first study that analyzes how MCI patients perform on the IFS. This screening tool accurately distinguished between this group and healthy elderly, but it was not sensitive to the distinct profile of executive impairments in MCI and AD.

## **B16. Is active bilingualism a cognitive reserve factor against cognitive decline?**

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Keywords: Cognitive reserve, Bilingualism, Dementia, Cognitive decline, Executive control

There is growing evidence that bilingualism acts as cognitive reserve (CR) factor in older adults and age-related disorders. In this study we investigated the underlying mechanisms (compensation vs. increased cognitive efficiency) which might explain such a bilingual advantage in the context of CR. To do so, we tested the cognitive efficiency of executive control (EC), attention and episodic memory in bilinguals who actively used their two languages vs. people with a low use of a second language (L2). We tested 215 bilinguals of three groups: healthy older adults, patients with Alzheimer's disease (AD) and with Mild Cognitive Impairment (MCI). 'Active' bilinguals were early and high proficient Catalan-Spanish bilinguals, they had a high frequency of use of their L2, and they switched between languages in their everyday life. 'Passive' bilinguals were Spanish speakers with exposure to Catalan (L2) and low used of their L2. First, we found that active bilingualism delayed the symptoms of AD and MCI, independently of education and other CR factors. Second, active bilinguals outperformed passive bilinguals only in tasks of conflict monitoring and not on episodic memory. To conclude, these data add new evidence that bilingualism acts as a CR factor, also in the preclinical stage of dementia. Specifically, the age of L2 acquisition and frequency of language use are crucial variables in determining such bilingual advantage. Finally, an increased EC efficiency boosted by the active use of the two languages would explain how bilingualism acts as CR factor in delaying the cognitive symptoms of age-related decline.

## **B17. Stop thinking about inhibition! Searching for individual and age differences in inhibition as a psychometric construct**

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**Keywords:** Executive functions, Cognitive control, Aging, Prepotent response inhibition, Resistance to distracter interference

Inhibition is often conceptualized as a unitary executive function reflecting the ability to ignore and suppress irrelevant information. At the same time, it has been subdivided into inhibition of pre-potent responses (i.e., the ability to stop dominant responses) and resistance to distracter interference (i.e., the ability to ignore distracting information). The present study investigated the unity and diversity of inhibition as a psychometric construct, and tested the hypothesis of an inhibition deficit in older age. We measured inhibition in young and old adults with 11 established laboratory tasks: antisaccade, stop-signal, color Stroop, number Stroop, arrow flanker, letter flanker, Simon, global-local, positive and negative compatibility tasks, and n-2 repetition costs in task switching. In both age groups, the inhibition measures from individual tasks had good reliabilities, but correlated only weakly among each other. Structural equation modeling identified a two-factor model with factors for inhibition of pre-potent responses and resistance to distracter interference. Older adults scored worse in the inhibition of pre-potent response, but better in the resistance to distracter interference. However, the model had low explanatory power because most inhibition measures had weak loadings on the factors. Together, these findings call into question inhibition as a psychometric construct and the hypothesis of an inhibition deficit in older age.

## **B18. Adults with single-domain amnesic mild cognitive impairment implement distinctive processing strategies to ensure an optimal task execution**

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Keywords: Go/NoGo, Amnesic mild cognitive impairment, Attention, Memory, ERPs

Amnesic mild cognitive impairment (aMCI) is thought to be a transitional state between normal aging and Alzheimer's Disease (AD). Adults with

multi-domain aMCI (mdaMCI, impairments in memory and other cognitive domain/s) show higher risk of progression to AD than those with single-domain aMCI (sdaMCI, only memory impairment). This study aimed to identify potential neurocognitive indexes of aMCI subtypes, with the purpose of facilitating their diagnosis. Fifty-four adults (51-87 years old), who performed an auditory-visual distraction-attention task, were divided in three groups: 20 healthy control, 22 sdaMCI and 12 mdaMCI participants. Performance and event-related brain potentials (ERPs) identified from 350 ms, in response to visual target stimuli, were evaluated. Adults with mdaMCI showed longer RTs than the control adults, and less correct responses than control and sdaMCI adults. Amplitude and latency of P3b ERP component (identified in the 350-700 ms interval) did not show any group differences, indicating no differences between groups in the efficiency of neural resources allocated to the categorization of target stimuli. A centro-parietal positivity (observed in the 700-1000 ms interval), labeled positive slow wave (PSW), was identified in the 91% of the sdaMCI participants, 25% of the mdaMCI participants and 30% of control participants. This component was interpreted as a reflection of serial decisions that follow target categorization, or a more sustained and effortful attentional allocation and more elaborate processing. Hence, it is possible that the sdaMCI adults were able to implement these additional operations as a compensation mechanism that allows them to maintain acceptable execution levels.

## **B19. Abnormal speech pauses in behavioural variant fronto-temporal degeneration: dysexecutive impairment?**

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Keywords: Fronto-temporal degeneration, Language disturbances, Narrative speech

Impaired narrative organization consequent to executive deficits has been reported as the most typical language impairment in behavioural variant fronto-temporal degeneration (bv-FTD). We report a single case study

of unusual speech disturbance in bv-FTD. IM, an 81-year-old, right-handed man and former HR manager, was referred for evaluation of altered speech and mood/personality changes (consisting of apathy alternating with restlessness and inappropriate behaviour) of about 1 year duration. A18F-FDG PET study showed severe frontal and temporal hypometabolism. Clinical and cognitive assessment led to a diagnosis of bv-FTD. Speech disturbances consisting of frequent and long pauses were reported as his first and most prominent symptom. In fact, IM's spontaneous speech was characterized by an unusual pattern of exceedingly long pauses (up to 20-30 seconds) intermingled with fluent and effortless production of utterances and fairly structured sentences. In some cases long pauses were easily overcome by nonspecific examiner's prompts. Frequency and length of pauses interfered significantly with narratives. Perseverative contents and mild discourse disorganization were also evident. Formal assessment of language failed to show significant deficits, with the only exception of reduced verbal fluency. Slowing or abnormally long pauses were not observed in any standardized test, including narratives elicited by verbal memory tasks. A variable pattern of dysexecutive deficits showed up on formal testing. It may be hypothesized that IM's unusual presentation of speech disturbances is related both to disruption of behavioural control and executive impairment, highlighted by the challenging task of spontaneously producing an effective narrative.

## **B20. Inhibitory control test using mobile computing of anti-saccades measurements as prototypical diagnostics for playful monitoring of Alzheimer mental state**

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Keywords: Inhibitory control analysis, Anti-saccades measuring paradigm, Mobile eye tracking in serious game design, Everyday monitoring of mental state, Users with dementia.

A key problem in developing knowledge about care in dementia and its impacting factors is lack of data. Longitudinal quantitative studies about mental processes in dementia are rare (Sütterlin *et al.* 2011). Cognitive and sensomotoric stimulation is decisive for meaningful treatment, however, lack of exercise is one of the major risk factors for dementia development (Norton *et al.*, 2014). A serious game was developed for multimodal training for users with dementia. Mobile eye tracking was applied for non-obtrusive daily sensing of mental states. An anti-saccade measuring paradigm was used for the analysis of eye movements that were captured during Tablet PC based game play. It detects impulse control problems as they occur in executive function related neurodegenerative diseases such as in Alzheimer (Crawford *et al.*, 2005). In a 1 month study with 15 participants excellent user feedback with high motivation to continue was collected. A classifier was trained to discriminate the eye movement features of non-dementia users (MMSE: M = 30) from those of users with dementia being within the early disease stage (MMSE: M = 25). People with dementia exhibited an error rate of M 43.2 % (STD 20.0 %) in contrast to people without the disease with error rate M 7.7 % (STD 5.0%). MMSE and error rate performed with a Pearson correlation of 0.632 ( $p = 0.09$ ). The serious game and its diagnostic toolbox offer entertainment, measuring and analysis of executive functions to enable people with dementia staying longer at home and slowing down the progress of disease.

## **B21. Performance-based everyday functional competence measures across the adult lifespan: the role of cognitive abilities**

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**Keywords:** Everyday life functioning, Aging, Performance-based measures

The ability to manage everyday problems is a major aspect that allows ensuring a healthy aging process. Yet, age-related effects in everyday com-

petences are under- investigated, or, when examined, only subjective self-report measures are used. The aim of this study was to examine age-related effects across the adult lifespan in everyday functioning. We used both performance-based (the Everyday Problem Test- EPT; Timed Instrumental Activities of Daily Living scale- TIADL) and self-report measures of functional abilities (Activities of Daily Living -ADL- scale; Instrumental Activities of Daily Living -IADL). We also study the relationships between everyday tasks and working memory (WM), processing speed (PS), and reasoning (R) and crystallized abilities (vocabulary, V, and reading comprehension, RC). Our sample consisted of 276 participants of 40 to 89 years of age. The EPT and the TIADL scale were administered, as well as WM, PS, R, RC and V tasks. We found that the EPT and time for TIADL were moderately related ( $r = -.50$ ). Through path models we found that increasing age was related linearly to decline in the EPT and quadratically to increase in TIADL time. Further, while RC was not related to the EPT, education, WM, R, and PS were, and the cognitive abilities explained 43 % of the variance in EPT. Altogether, the present results call upon the need to consider performance-based measure of everyday competences rather than solely subjective ones in examining age related effects. They also stress the crucial role of processing resources in those complex abilities.

## **B22. Neural and behavioral impact of WM and self-regulation training in school- aged children**

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**Keywords:** Working memory, N-Back, Functional Magnetic Resonance Imaging, Typically developing children

Previous work indicates the association between working memory (WM) performance, attention and impulsive behaviours (Klingberg 2010). Cognitive training programs may enhance the maturation of fronto-parietal networks underlying the age-related increase in cognitive control (Crone



et al 2006). We conducted a longitudinal study of the impact of WM and self-regulation training on cognitive abilities and school performance in 7-8 year-old, typically developing children. Here, we focus on neural and behavioural effects of WM training during a WM task. A subsample of the larger behavioral study (N = 28), performed an N-Back task (baseline: 0-1 back; WM: 2-3 back) together with fMRI. The data were analysed using a repeated measures ANOVA 2x2 (group condition: WM training (N = 14)/control treatment(N=12); task condition: baseline/WM). Compared to the control group, the WM training group showed a higher percentage of correct responses and reduced number of commission errors during baseline, together with reduced variability of their responses (standard deviation of response time) during both baseline and WM conditions. The fMRI data showed that group differences in performance were accompanied by significantly increased activation in putamen, dlPFC, IFC/insula and anterior cingulate cortex. Increased activation in the caudate/putamen was associated with less commission errors across all subjects. Activity in prefrontal and parietal cortex during the N-back was associated with performance on attention, WM and inhibition measures at one- year follow-up. The WM training showed a significant impact on behaviour and neural networks, being strongest for attention and inhibition processes, pre- requisite skills for working memory as well as many other high-level cognitive processes.

## **B23. Characterizing the relationship between executive functions and academic performance in adolescence: Implications for genetic research**

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Keywords: Educational Attainment, Adolescence, Executive Function

Contemporary genetic studies use large samples and general phenotypes to characterise the genetic correlates of individual differences in academic achievement. Although they have provided important biological insights these studies lack the ability to study specific links between genes, cognitive

processes and particular subject performance. The objective of the present study was to characterise the nature and magnitude of the relationship between executive functions (EFs) and performance in maths, English and science during adolescence – a period during which EFs are still developing. Principle component analyses were used to create latent variables from 11 cognitive measures and separately from questionnaires in the Avon Longitudinal Study of Parents and Children sample ( $N = 5,838$ ). These were entered in multiple regressions as possible predictors of National Curriculum levels in maths, English and science across ages 11 and 14. Controlling for IQ and socio-economic status, updating and sustained attention accounted for significantly more unique variance in maths (3.3% and 5%), than science (1.3% and 2.4%) and English (0.9% and 2.7%). Parent report measures of inattention explained more variance (6.2%) in English and maths than in Science (3%). Neither the questionnaire nor the experimental measure of inhibitory control explained unique variance in performance. In summary, cognitive measures of EFs show specific associations with academic performance over and above IQ and parent report measures. Contrary to expectations, maths and science showed quite different associations and in contrast to findings from younger children, inhibitory control was not a significant predictor, suggesting different cognitive strategy use in adolescence.

## **B24. The Role of the Frontal Lobes in Anosognosia for Theory of Mind Deficit: a Single Case Study**

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**Keywords:** Theory of Mind, Anosognosia for ToM deficit, Lesion Study

Theory of Mind (ToM) refers to the ability to understand and predict others' mental states. Frontal regions play a key role in ToM and lesion studies

reported damages within the anterior cingulate and orbitofrontal cortices in adults showing ToM deficits. However, it is still debated the role of patients' awareness of ToM deficits and its neural substrates. In this study, we investigated the anosognosia for ToM deficits. In this single-case study, we tested A.P., a traumatic brain injury (TBI) patient. The ToM abilities were investigated through ToM-test, Faux Pas, Eye Reading and Irony-Comprehension test. The awareness was assessed by means of a non-structured interview, the Dysexecutive- Questionnaire and the Patient-Competency-Rating-Scale. The Behavioral- Assessment-of-Dysexecutive-Syndrome was assessed as to control for the executive functioning. The neural correlates of patient's specific deficits were investigated through a neuroanatomical study. The patient showed an impaired performance during ToM assessments. Interestingly, he presented a selective lack of awareness for ToM deficits. His performance in the executive functions assessment was spared. The lesion analysis showed bilateral lesions in the orbitofrontal and lateral basal temporal regions. An explorative tracts analysis suggested a damage of the arcuate fasciculus and the anterior cingulum. We reported a specific deficit in awareness regarding ToM impairment in a TBI patient. The lesion analysis suggested a role of the frontal lobe in anosognosia for ToM and supported the hypothesis of functional modularity in anosognosia (Mograbi & Morris, 2013). Further investigations are needed in order to better understand the networks involved in deficits of awareness.

## **B25. An Executive Function Training for preschool children: Effectiveness and transfer to pre academic skills**

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**Keywords:** Executive function training, Preschool, Pre academic skill

Promising results have been reported regarding interventions designed to promote the development of Executive Function (EF) (Diamond & Lee, 2011). Nevertheless, recent reviews point to several open questions (Diamond

& Ling, 2016; Jolles & Crone, 2012; Melby-Lervag & Hulme, 2013), such as no compelling evidence that an improvement in EF skills may transfer to other abilities, for example school achievement (Jacob & Parkinson, 2015). The current study examines the efficacy and the cross-domain transfer of a training that was found to be effective in promoting EF in a sample of 94 typically developing five-year-old children (Traverso *et al.*, 2015). The training efficacy was assessed when teachers administered the training in public pre-school educational services; the cross-domain transfer was assessed by evaluating the training effects on pre-academic skills. A pre- and a post-test assessment were conducted using a large EF and pre-academic skill task battery. The results indicate that the experimental group outperformed the control group in one of the highest cognitive demanding EF tasks and in some measures of pre-academic skills. Using a mediation analysis, we found that the EF training contributed to increase EF skills that in turn affected pre-academic skills. The findings indicate that it is possible to enhance EF skills with relatively simple interventions and that the increase in EF may transfer to pre-academic skills. Low- cost EF trainings should be considered to increase school readiness and reduce the achievement gap, especially in children at risk for school failure, such as children from poor and minority backgrounds.

## **B26. Atypical neuronal activation during a spatial working memory task in 13-year- old very preterm children**

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Keywords: Very preterm, Working memory, Manipulation vs. manipulation Processes, Neuronal Networks, fMRI

Children born very preterm (VP: <32 weeks' gestational age) are at risk for unfavourable outcomes in several cognitive domains, including spatial working memory (WM). The underlying neural basis of these cognitive impairments is poorly understood. We investigated differences in neuronal activation during spatial WM using a backward span (BS) task relative to a control (C) task in 45 VP children and 19 term-born controls aged 13 years. VP children showed significantly more activation in the bilateral superior frontal gyrus and significantly less activation in the left parahippocampal gyrus compared with controls. We further explored the distinct contributions of maintenance and manipulation processes of WM using forward span (FS)>C and BS>FS, respectively. There were no significant group differences in neuronal activation for FS>C. However, BS>FS revealed that VP children had significantly greater activation in the left middle frontal gyrus, in the left superior parietal gyrus and cerebellum, and significantly less activation right pre- and postcentral gyrus and left insula compared with controls. Taken together these results suggest that VP children at 13 years of age show an atypical neuronal activation during spatial WM, specifically related to manipulation of spatial information in WM. It is unclear whether these findings reflect delayed maturation and/or recruitment of alternative neuronal networks as a result of neuroplasticity.

## **B27. The role of genes on Executive Functions in pediatric patients with epilepsy**

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Keywords: Genetic vulnerability, Executive functioning, Neurodevelopment, Epilepsy

Chronic diseases including childhood epilepsy often display compromised executive functioning (EF) which significantly affect their development and

Quality of Life. We tested the hypothesis that some specific polymorphisms, linked to neurodevelopment, may constitute a risk factor and compromise EF in children with epilepsy and define early interventions. Thirty-six pediatric patients diagnosed with epilepsy were enrolled. Besides the presence of EEG alterations a subgroup of patients had difficulty in the language domain. DNA was collected for the analysis of the polymorphisms. Patients underwent a short battery of neurocognitive and psychosocial tests composed by: Brief Rating Inventory of Executive Function Test (BRIEF), Psychological Assessment Tool (PAT generic), Children Color Trail Test 1 and 2, Pegboard Test, Resiliency Test, and the Strengths and Difficulties Questionnaire. Patients had a higher prevalence of deficits in executive functioning especially with respect to working memory and planning skills. Also 1/3 of patients had disorders related to learning and/or language problems, such as, dyslexia. At this initial stage of our longitudinal study, we observed that 5% of the sample is homozygous for the Methylene tetrahydrofolate reductase (MTHFR C677T) gene polymorphism, which seems to have an important role concerning the specific profile of deficits related to executive functions observed in our patient population. In conclusion, genetic vulnerability expressed as polygenic risk should be considered as part of behavioral and cognitive risk assessment, especially with respect to executive functioning. Multidisciplinary longitudinal risk assessment will help to capture the functional domains most compromised in time and allow for early intervention.

## **B28. Profiling Executive Function and Self-Regulatory Behaviours in Developmental Dyslexia: Cognitive and Neural Bases of Response Inhibition explored**

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Keywords: Developmental Dyslexia, Event-Related Potentials, Self-Regulation, Response Inhibition

Previous executive function (EF) profiling studies of developmental dyslexia (DD) have produced mixed results, due in large part to a weak theoretical and methodological approach to choosing EF tasks. Latent analyses suggest that EF is comprised of related (common EF: inhibition) and separate abilities (updating and switching) (Miyake & Friedman, 2012) that can be sensitively measured in smaller samples with z-mean composites (Snyder, Miyake, & Hankin, 2015). This approach is not typically reflected in DD EF profiling studies. EF is also core to self-regulatory and socio-emotional control and if impaired in DD, can negatively impact on both. Moreover, the neural bases of EF in DD are also unclear. The present study therefore aims to explore in a DD sample (1) EF with z-mean composites using the Miyake framework, (2) N2 and P3 Event-related potentials (ERPs) during a measure of common EF (Go No-Go), and (3) self-regulatory and socio-emotional difficulties. Fifty-Seven children (25 control, 32 DD) aged 10-12 years completed a battery of inhibition (EEG), updating, switching, reading, self-regulation and socio-emotional measures. Preliminary analyses suggest that DD is associated with reading ( $F(1,55) = 78.65$ ,  $p < .001$ ,  $d = 2.42$ ), self-regulatory ( $F(1,55) = 22.21$ ,  $p = .000$ ,  $d = 6.79$ ) and inhibition difficulties (Error (trend):  $F(1,53) = 3.24$ ,  $p = .078$ ,  $d = 2.76$ ; RT:  $F(1,53) = 5.38$ ,  $p = .024$ ,  $d = 2.97$ ). No differences were found for socio-emotional problems, updating or switching ( $p > 0.05$ ). N2 and P3 differences during the Go No-Go task will be discussed in terms of possible compensatory mechanisms. Findings suggest that inhibition may be compromised in DD and may be a candidate for targeted intervention.

## **B29. Predictive Factors for Executive Functions in 3-year-old Thai Children**

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**Keywords:** Predictive factors, Executive functions, Preschoolers, Parenting, Temperament, Cognitive development

Executive functions (EFs) are crucial for goal-directed and problem-solving skills of children. Children who had higher verbal cognitive ability and were raised by responsive caregivers tended to have higher EFs documented in previous studies. To our knowledge, there are no studies examining such associations in Thai preschoolers. The objective of this study was to investigate whether infant temperament at 6 months of age, parenting styles, and child development at 3 years of age are associated with EFs in 3-year-old children. EFs of 200 children were rated by their mothers using the Behavior Rating Inventory of Executive Function- Preschool and were assessed by developmental pediatricians. Child development and parenting styles were evaluated by the Mullen Scales of Early Learning and Parenting Styles and Dimensions Questionnaire, respectively. Infant temperament questionnaire was used to assess child temperament at 6 months of age. Multiple linear regression analyses were performed. Preschoolers with poorer EFs including inhibitory self-control, flexibility, and emergent cognitive indices were significantly associated with permissive parenting style ( $B$  coefficients = 3.949,  $p < 0.01$ ;  $B = 3.537$ ,  $p < 0.01$ ; and  $B = 4.755$ ,  $p < 0.01$  respectively). Infants with difficult temperament at 6 months of age were related to poorer EFs mentioned above. Cognitive development was also significantly associated with EF tasks. Permissive parenting style, difficult temperament, and child cognition were associated with preschooler's EFs. As a result, parents should be advised about appropriate parenting with respect to their children's temperament for promoting better EFs and cognition.



## **B30. Theory of mind is severely impaired and dissociated from cognitive flexibility in cocaine addiction**

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**Keywords:** Theory of mind, Cognitive flexibility, Cocaine addiction, Double dissociation

Cocaine addiction is related to different neuropsychological alterations, including executive ones. Among these, cognitive flexibility has received particular attention whereas social cognition has been much less investigated. Here we submitted a sample of 50 dependent cocaine users and a control sample of 46 stimulant-naïve participants matched for age and years of education, to a battery including classical tests of cognitive flexibility (WCST) and attention/visuomotor performance (SDT, TMT), as well as a social cognition test based on Theory of Mind (TOM). Results revealed TOM deficits in the patients group, who significantly differed from the control one ( $p < 0.0001$ ). The number of perseverative errors at the WCST tended to be significantly higher ( $p = 0.06$ ), while patients outperformed controls on the TMT test ( $p < 0.01$ ). Within the patients group, a double dissociation was observed between performance at social cognition and cognitive flexibility: 9 patients performed below the cutoff to the TOM test but in the normal range to the WCST, and 6 patients showed the opposite pattern. Five patients failed to both tests. The present study therefore highlighted a severe deficit of TOM abilities as well as a double dissociation between cold (flexibility) and hot (TOM) executive functions in cocaine addiction. The relationship between the observed neuropsychological patterns and the personality profiles and psychopathological variables in patients is now under investigation. Given the relevance of social functioning in the development and treatment of drug

dependence, the potential influence of individual and group-based clinical treatment on TOM abilities (and viceversa) will be also evaluated.

## **B31. Investigating the development of executive functions in adolescence**

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Keywords: Adolescence, Inhibition, Verbal memory, Monitoring, Shifting

The development of executive functions (EFs) has primarily been studied among children up to early adolescence, despite research suggesting that EFs continue to develop throughout adolescence and into adulthood. This study examined EF development during the later stages of adolescence. Adolescents ( $N = 348$ , mean age 15.74 years, age range 14-18 years) were assessed individually on standardised measures of inhibition (Stroop), shifting (sorting) and monitoring (backwards digit recall). Adolescents' scores were examined in relation to their age and other variables of interest. Adolescents' age was significantly, albeit weakly, related with their inhibition and monitoring scores ( $r = .21$  and  $r = .12$  respectively, both  $ps < .05$ ), but not with their shifting score ( $r < .001$ ,  $p > .05$ ). Age additionally correlated with colour naming ability,  $r = .24$ ,  $p < .05$  and verbal memory capacity,  $r = .18$ ,  $p < .05$ ; non-executive processes measured by control conditions of the inhibition and monitoring tasks respectively. Inhibition and monitoring were further analysed using regression analyses, which showed that 50% of the variance in inhibition scores and 40% of the variance in monitoring scores (both  $p's < .001$ ) were explained by a combination of variables, including pupil's age, socioeconomic status, non-executive processes and whether or not they suffered from a condition. Overall, within this large sample of older adolescents, there appears to be little evidence of age-related changes in EFs. It is noteworthy that colour naming ability and verbal memory capacity explained the most variance in the inhibition and monitoring scores respectively, showing

the importance of controlling for non- executive processes that affect performance on EF tasks when examining age related changes in EFs.

## **B32. Component deficits of visuospatial neglect after right hemisphere damage: magnetic attraction of attention and impaired spatial working memory**

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**Keywords:** Attention, Spatial working memory, Neglect, tractography, Clinical anatomical correlations

Right brain-damaged patients presenting visuospatial neglect fail to detect left- sided objects. The precise mechanisms are debated, with some consensus that distinct component deficits associate and interact in different patients. Here we used a touch-screen based procedure to study two putative component deficits of neglect, rightward “magnetic” attraction of attention and impaired spatial working memory, in a group of 47 right brain-damaged patients, of whom 33 had neglect signs. Patients performed a visual search task by touching targets on a computer screen. After touch, targets could be tagged by a change in color,

disappear from the screen, or show no change. Magnetic attraction of attention was defined as more left omissions on the tag condition than on the disappear condition, where disappeared right-sided targets could not capture patients' attention. Compared with the tag condition, impaired spatial working memory should instead produce more neglect on the no change condition, where no external cue could indicate that a target had already been found. Results suggested the presence of both deficits in most patients, with some patients presenting dissociated patterns of performance. Lesion analyses taking into account both grey matter and white matter were consistent with the typical patterns of fronto-parietal and occipito-frontal disconnection suggesting possible co-localization of attentional and working memory processes in fronto-parietal networks. These findings confirm the hypothesis of the co-occurrence of distinct cognitive deficits in visual neglect and stress the necessity of multi-component models of visuospatial disorders, involving spatial attention, but also the monitoring, inhibition and updating of spatially-based information.

### **B33. Random generation of items in frontal lobe pathology**

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Keywords: Random generation, Inhibition, Frontal lobe pathology

Random generation requires efficient active inhibition of strategies spontaneously employed for retrieving individual items from their organized mental sets. Therefore it may prove to be a counter-intuitive manner of assessing the executive functioning. Random generation might rely on the same mechanisms as those involved in solving classical tasks for assessing executive functions such as the Controlled Oral Word Association Test and the Stroop test. We compared performances on random generation tasks (using a variety

of lexical and semantic sets, including letters, syllables, numbers, months of the year, color names etc.) in equivalent groups of subjects: "healthy" controls ( $n = 17$ ), schizophrenia patients ( $n = 16$ ), psychotic non-schizophrenia patients ( $n = 16$ ), and stroke patients with frontal lobe lesions ( $n = 19$ ). The performances of the vascular patients proved to be the most (and significantly) altered as compared with the control group, with the psychiatric patients' performances placed in between. The obvious difficulty of random generation in frontal pathology is suggestive for its disruption of executive functioning. A dissection of the mental mechanisms involved in random generation of items alongside with some of their possible dysfunctions in dysexecutive syndrome of frontal lobe pathology is advanced in an attempt to refine the task for clinical use.

### **B34. Brain event-related potentials and their source localization during attention network test in typically developing children**

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Keywords: Brain event-related brain potentials, Source localization, Attention, Network Test (ANT), N1, P3

Attention involves three sophisticated functional components, alerting, orienting, and inhibition. Here we studied EEG-based brain event-related brain potentials (ERPs) in school-aged children during Attention Network Test (ANT) measuring these components. The aim was also to characterize the source activations of attention processes. The participants were shown fishes, and the middle one was 'swimming' either in the same (congruent target) or in the opposite direction (incongruent target) compared to the other fishes. In a part of the trials, the position of the fishes (upper or lower screen) was indicated by a cue. EEG was recorded with 128 electrode system with simultaneous eye-tracking from 32 typically reading 12-13-year-old children. The ERPs and the cortical sources were modeled as multiple equivalent cur-

rent dipoles using FieldTrip and BESA software, respectively. Behaviorally, the reaction times were shorter for target fish after the double cue vs. no cue (alerting), after the spatial cue vs. centre cue (orienting), and for the congruent vs. incongruent condition (inhibition). The preliminary results showed the modulation of the target N1 response by alerting and orienting, and the target P450-650 response by inhibition. N1 response activation for attention was localized in the occipital, fusiform, parietal, and left lateral prefrontal cortex. These high-density EEG/ERP brain response effects and their source localization can be further used to study neural level associations of attention with related cognitive functions and differences in neural mechanisms between typically developing children and for example those with attentional problems.

## **B35. The Effect of Cerebellar Lesions on Visual Attention**

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Keywords: Attention, Executive Processing, Dual-tasking

Cerebellar involvement in motoric coordination has long been established; however, increasing evidence implicates the cerebellum in executive functions, for example in dual-tasking, the concurrent execution of two tasks. The current study therefore assessed how acquired cerebellar lesions affected the simultaneous performance of a cognitive and a motoric task in infarct patients compared to controls. The patient group consisted of 22 individuals with unilateral cerebellar infarcts, isolated strictly to the cerebellum. A healthy matched control group was also tested. Both groups completed a motoric tapping task and a visual attention test under single-task conditions, as well as both tasks simultaneously in a dual-task condition. The visual attention task, based on the Theory of Visual Attention, provided estimates of the size of the storage capacity of the visual short-term memory (VSTM; parameter K), as well as the processing speed (parameter C) of participants. In patients, C was significantly reduced compared to controls in the single-task ( $p = 0.037$ ), but not in the dual-task condition ( $p = 0.083$ ), whilst K was

significantly reduced in patients in both the single-task ( $p = 0.021$ ) and the dual-task conditions ( $p = 0.049$ ). Tapping performance was worse in patients as compared to controls, despite the lateralization of the infarct having no significant effect on tapping performance, indicating that diminished performance arose due to cognitive dual-tasking costs, rather than from motoric deficits. Overall, the findings suggest that the K parameter is strongly related to the amount of dual-task costs experienced by both groups, and that the cerebellum plays an important role in dual-tasking.

### **B36. Cognitive control in severe obese individuals: an ERP study**

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Keywords: Cognitive control, Event-related potential (ERPs), Obesity, Food-related attention

Severe obesity has been associated with executive dysfunctions such as poor cognitive control during interference tasks. A source of behavioral studies showed lower cognitive control in obese compared to normal-weight when food-related stimuli are present, suggesting enhanced attention toward food (i.e. food-related attentional bias), which may reduce the efficiency of cognitive control. Here, cognitive control of interference in presence of food-related stimuli was assessed by means of event-related potentials (ERPs) and behavioral measures of cognitive control in severe obese individuals. Twenty-four obese and 28 normal-weight were evaluated in fasting state. Cognitive control in presence of food-related stimuli was investigated with a version of the Simon task modified with task-irrelevant food, object and neutral distractors. ERPs and reaction times (RTs) were registered in

spatial corresponding (C) and non-corresponding (NC) conditions for each distractor. Larger Simon effect in presence of food-related distractors was found in the obese group. The N2 amplitude was higher in C compared to NC trials only in normal weight, whereas this effect was not present in the obese group. Longer P3 latency was found in obese compared to normal-weight. Attentional bias toward food interferes with cognitive control in severe obese individuals, supporting previous evidences for a food-related motor impulsivity. For the ERPs, the finding of higher N2 amplitude in conflict trials (NC) in normal-weight, but not in the obese group, suggests impaired conflict detection in the latter. Longer P3 latency observed in the obese may reflect a slowing down in information processing speed.

### **B37. Connectivity correlates of impaired executive functioning in anorexia nervosa**

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Keywords: Anorexia Nervosa, Iowa Gambling Task, Brain Connectivity

Anorexia nervosa (AN) is a severe psychiatric disturbance characterized by reduced food intake, abnormally low body weight, intense fear of gaining weight, disturbance of body image and persistent lack of recognition of the seriousness of the condition. AN patients typically show weaknesses in set-shifting, decision-making, central coherence, and behavioral inhibitory control. Our studies showed that set-shifting difficulties and cognitive inflexibility appear to be trait-related (i.e., no improvement is shown after weight recovery), but significantly influenced by the Catechol-O- methyltransferase (COMT) genotype in the underweight condition. Similarly, the functional connectivity of prefrontal cortex is affected by this polymorphism in the underweight AN group. The underweight AN group, but not the weight-recovered group, displayed significantly higher reaction times at the Stop-Signal test, a behavioral inhibition task. This impairment seems to be explained by significantly lower functional connectivity in the ventral attention network, although the association between functional connectivity within this network and the Stop-Signal reaction times appears to be modulated by the polymor-



phism of the serotonin transporter gene (5HTLPR). Both veridical (Iowa Gambling Task) and adaptive (Cognitive Bias Task) decision-making performances are significantly impaired in anorexia nervosa patients and this is associated with reduced connectivity within the executive and orbitofrontal networks. Studies about connectivity correlates of impaired cognitive functioning in anorexia nervosa can provide new insights into the pathophysiology of this complex disease and guide target selection for Transcranial Magnetic Stimulation (TMS) in order to modulate pathological network interactions.

## **B38. Basic language skills, executive functions, and their interaction in complex language tasks Evidence from Phenylketonuria**

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**Keywords:** Language, Pragmatics, Executive Functions, Speed of processing, Neural metabolism

It remains unclear whether executive functions (EF) are distinct functions supported by specific neural circuitry or only descriptive labels referring to properties of the cognitive system which emerge when many operations need to be coordinated across domains. According to this second view, impairments in tasks allegedly tapping EF will follow diffuse brain damage simply because these tasks are more complex and provide more sensitive measures of brain health. In complex tasks, minor impairments in basic functions will sum up and create significant delays and/or catastrophic failures to complete the task. In our study, we assess these possible interactions in samples of adults with Phenylketonuria, an inherited metabolic disease causing diffuse brain damage (AwPKU; N = 12-30). We found some deficits in complex language tasks involving: 1. Recounting a story 2. Comprehension

of humour, metaphors, and inferred meaning and 3. A focused search of the lexicon (The Hayling sentence test). In contrast, no impairment was detected in basic language skills even when sensitive measures were used (because in the context of a complex task or because reaction times were taken). AwPKU planned their narratives less well, but showed a normal mean sentence length (a measure of syntactic processing), speech rate and rate of different kinds of speech errors. Similarly, they showed no impairments in a taxing naming tasks assessing semantic interference and tests of prosody discrimination. This dissociation suggests that deficits of EF are primary and not predicated on more basic impairments.

### **B39. Selective deficits of speed of processing in adults with phenylketonuria (PKU): Implications for executive functions**

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**Keywords:** Speed of processing, Executive Functions, Neural metabolism

Deficits in complex tasks involving reasoning, planning and monitoring could be affected by a generalized reduction in speed of processing because delays in the individuals operations needed to carry out a complex task may accumulate to the point where returning an answer is significantly delayed or not at all possible. In this study, we examined the interplay between deficits of speed of processing and executive functions (EF) in a sample of early threatened adults with Phenylketonuria (PKU; AwPKU; N = 37). PKU is an inherited metabolic disease characterized by a disruption of myelination, deficits in EF and a reduced speed of processing. We found that contrary to general views, AwPKU were not characterized by a generalized speed deficit. Instead, their performance could be explained by two more specific impair-

ments: a) A deficit in the allocation of visuo-spatial attention which reduced speed of processing in visual search tasks, and, possibly, in some reading conditions and in visuo-motor coordination tasks and b) A more conservative decision mechanism which slowed down returning an answer across domains and which, for language tasks, explained a fixed delay in responding compared to controls, independently of difficulty of condition. These results suggest that the impairments in EF seen in AwPKU are not the consequence of a generalized speed deficit. Similar conclusions may apply to other populations. Similarities with patterns in aging will be discussed. More generally, our results argue for an independent representation of EF in the brain.

## **B40. Executive functions in sport. A preliminary study in elite volleyball players**

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Keywords: Executive functions and sport, Attention, Task switching

Sport science suggests that athletes' performance depends also by developed and established cognitive abilities. The aim of this study is to investigate the correlation between the role played in an open-skill sport and the executive processing of individual players, in order to evaluate if the cognitive demands of the game could modulate the cognitive behaviour. Twenty-seven volleyball players were evaluated in a task switching protocol (TS). This test is sport-specific, since it uses pictures taken during the game and thus related to situations very close to everyday experience of participants. To every one two tasks were presented: the first asked to recognize the type of action

(attack, defense) while the latter to identify the T-shirt's color (white, red). Reaction times to switch and repetition trials, switch costs (SC) and accuracy were taken into account as dependent variables. To assess differences in roles, participants were subdivided into three groups according to the characteristics of the role played (striker, defender and mixed). Data showed that the mixed-group appeared to be more accurate than others. There were also significant differences in reaction time: striker and defender groups resulted faster than mixed-group. The results confirm that the role played has an influence on cognitive aspects and performance. We observed that in volleyball players, each role has specific characteristics related to cognitive processing. This TS protocol can help to infer the different aspects of executive functioning used by each role and consequently allowing to train specific cognitive domains related to the role played.

## **B41. Impairment of verbal fluency in SCA36: a model to study the cerebellar cognitive affective syndrome**

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**Keywords:** Spinocerebellar ataxia type 36, Cerebellum, Verbal fluency

SCA36 or “Ataxia da Costa da Morte” is a type of spinocerebellar ataxia. Due to its relatively invariable clinical and progression pattern, this SCA

may be useful for the study of the cerebellar cognitive affective syndrome (CCAS). Verbal fluency a particular type of executive function and specific linguistic ability - is usually altered in CCAS. The objective of this study is to determine if verbal fluency is altered in different stages of SCA36. 30 patients with genetically confirmed SCA36 were assessed with the SARA scale for cerebellar motor impairment ( $SARA < 3$  = preataxic;  $SARA \geq 3$  = ataxic), as well as with the FAS-test for phonological fluency and the animals test for semantic fluency. Phonological verbal fluency was impaired in preataxic patients (median =  $-0.78 \pm 2.6$ ,  $p < 0.043$ ), whereas semantic verbal fluency was intact in the same patients (median =  $-0.33 \pm 2.7$ ,  $p = 0.619$ ). In the ataxic group, both verbal fluencies were below norm data (phonological median:  $-1.22 \pm 3.8$ ,  $p < 0.011$ ; semantic median =  $-1.0 \pm 4.3$ ,  $p < 0.022$ ), correlating with motor impairment. Cerebellar damage affects phonological fluency more than semantic fluency. Our data support the hypothesis that phonological fluency is more depending on executive control than semantic tasks, since phonological fluency requires the generation of new strategies to facilitate more correct answers.

## **B42. Cognitive flexibility ability of patients with obsessive compulsive disorder**

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**Keywords:** Obsessive-Compulsive Disorder, Flexibility, Executive Functioning

The available literature suggests that people with obsessive-compulsive disorder (OCD) show dysfunction at cortico-basal-thalamo-cortical loops. As cognitive flexibility is an ability that is thought to be dependent on cortico-basal circuits, it is expected that OCD patients show impairments in neurocognitive assessments targeting cognitive flexibility. The aim of this preliminary study is to assess cognitive flexibility in moderate to severe cohort of OCD patients as compared to non-clinical controls (NCC). Cognitive flexibility ability was assessed by the Wisconsin Card Sorting Test (WCST), STROOP, and Trail Making Test B (TMT-B) in 10 OCD patients (Mean age,  $33 \pm 11$  years) and 10 NCC (Mean age,  $36 \pm 10$  years). Mann-Whitney U tests showed that OCD patients have a higher interference index when compared to NCC, as assessed by the TMT ( $U = 21$ ,  $p = .028$ ). Moreover, despite not statically significant, there are other results suggesting cognitive flexibility deficits in OCD patients: increased number of preservative responses during WCST ( $U = 25$ ,  $p = .058$ ), as well as increased time to completion ( $U = 25$ ,  $p = 0.59$ ) and more prone to errors ( $U = 29.5$ ,  $p = .078$ ) in the TMT-B. The profile of cognitive flexibility deficits found in this preliminary study suggest that moderate to severe OCD patients show cognitive flexibility impairments which can be explained by their altered cortico-basal loops. Future studies should increase the sample size and develop neuroimaging paradigms that will be able to correlate impaired behavior performance with brain's functional activity.

### **B43. Executive functioning in children with Autism Spectrum Disorder without Intellectual Disability**

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**Keywords:** High Functioning Autism, Flexibility, Executive Functioning

High-functioning autism (HFA) children do not present intellectual disability but the literature reports impairments regarding executive functioning (EF). Furthermore, differences between HFA children regarding their behavioral profile were described, and seem to be associated with specific cognitive outcomes. The goal was to examine the differences in EF between HFA and typical developing (TD) children, and verify if there is an association between them and their behavioral characteristics. Twenty children (male), 10 HFA and 10 TD, matched by age. WISC-IV was used to assess children's Intelligence Quotient (FSIQ). EF was assessed with WCST and STROOP Test. Behavior characteristics were assessed using CBCL. Differences between HFA and TD were evaluated by Mann-Whitney test and correlations analysis were performed by Pearson's Correlation test. Differences were found regarding the maximum digits recall in direct order ( $p = .005$ ) and in inverse order ( $p = .003$ ). HFA children performed better than TD. Regarding WCST, significant differences were found in perseverative response ( $p = .023$ ), perseverative errors ( $p = .023$ ), and the total number of errors ( $p = .023$ ). HFA children performed worse than TD. No significant differences between groups were found in STROOP interference. Neither significant correlation were found between EF and behavioral characteristics (CBCL) in HFA children, but 6/10 HFA children showed clinic range in attention problems and 4/10 in social problems subscale. Our results support the studies reporting worst performance in cognitive flexibility in HFA, but not in working memory nor in inhibition abilities. Since EF contributes to HFA behavioral profile, is necessary taking them into account for clinical proposes.

## **B44. Intervention that activates executive functions improves students' ability to overcome intuitive interference in mathematics**

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Keywords: Intuitive interference, Mathematics and science education, Inhibitory control mechanisms, Warning intervention

Students' difficulties in mathematics and science may stem from interference of the task's irrelevant salient variables. Here, we focus on a comparison of perimeters task, in which 'area' is an irrelevant interfering salient variable. In congruent trials (when there is no interference of 'area' to comparison of perimeters), accuracy is higher and reaction time is shorter than in incongruent trials (when 'area' variable interferes). A brain-imaging study related to this task indicated that correctly answering the incongruent condition is associated with activation in prefrontal brain regions known for their executive inhibitory control. These findings suggested that intervention aimed at activating inhibitory control mechanisms could improve students' success. Our goal was to explore whether intervention that activates executive functions by explicitly warning students about the possible interference of the variable 'area' would improve their performance. Eighty-four sixth graders performed the same comparison of perimeters reaction time test, with warning intervention (warning group) or without it (control group). Accuracy in the warning group was significantly higher in incongruent conditions and reaction time was significantly longer in all conditions than in the control group. The results suggest that the explicit warning activates inhibitory control mechanisms and thus helps students overcome the interference. The findings point to the possibility of improving students' problem-solving abilities through simple and focused interventions that explicitly warn them about the trap in the task. Such research-based simple interventions appear to require only teachers' knowledge and awareness and could complement the traditional educational technique of supporting relevant content knowledge.



## **B45. A session of moderate-intensity continuous exercise, but not a high- intensity interval protocol, boosts executive function. An ERP study**

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**Keywords:** Physical exercise, Executive function, Flanker task, ERP, N2 component

Previous studies indicate that a session of aerobic exercise promotes executive function. However, it still remains elusive whether all forms of aerobic exercise benefit executive function to the same extent. The aim of the present study was to examine how two different types of aerobic physical exercise influence behavioral and neural markers of executive function in a flanker task. Twenty healthy male participants completed three sessions on cycle ergometer (one session per week; each lasting 24 min): 1) a moderate-intensity continuous exercise (intensity below the second ventilatory threshold), 2) high-intensity interval exercise (3 min of intensity at first ventilatory threshold interspersed with 3 min at intensity above second ventilatory threshold) and 3) a no-exercise seated control (without pedaling). The order of the sessions was randomized and counterbalanced across participants. Approximately 10 min after each session, participants performed a flanker task during which continuous EEG data were collected. Behavioral results revealed that participants performed the task more accurately after the moderate-intensity exercise session, relative to the two other sessions. Similarly, ERP data revealed more prominent N2 component after a moderate-intensity exercise session, relative to the other sessions. Both findings consistently suggest that a moderate continuous, but not the high- intensity interval, exercise increases effectiveness of executive function in the flanker task. Overall, results suggest that not all kinds of aerobic exercises boost the executive function equally.

## **B46. Persistent modification of cognitive control through implicit attention training**

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Keywords: Attention, Cognitive Control, Training, Generalization, Conflict

An important aspect of cognitive control is to direct attention towards relevant information and away from distracting information. This attentional modulation is at the core of several influential frameworks. However, its cross-time and cross-task generalizability are unsure. To address this issue, two groups of participants were invited to the lab on three consecutive days. On day 2, they performed an arrow priming task which trained them to adopt an attentional bias towards (prime-attended group) or away from (prime-diverted group) a potentially conflicting prime. Cross-time generalization of the attention training was measured by assessing task performance on the same task without the attentional manipulation directly after training (day 2) and the next day (day 3), and comparing it to baseline (day 1). Performance on this cross-time transfer task showed a difference in attentional modulation between groups directly after training that persisted the next day. No cross-task generalization was found to two other tasks that were closely or more remotely related to the trained task. Together, these results are in accordance with cognitive control frameworks that allow for relatively persistent changes in attentional modulations (for example through synaptic plasticity) but limit effects to the specific features of the trained task.

## **B47. Executive Function: how to improve academic performance with cognitive motor interventions**

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Keywords: Fluidity, Coordination, Cross patterns, Timing, Planning, Self regulation, Activation, Sequences

Many students may develop patterns of lack of self regulation, planning and lack of accuracy in timing, for this reasons they need to be trained in a better executive functioning system in terms of fluency, to obtain remarkable performance in academic level. Our research, conducted over 10 years of observations, rehabilitative treatments and targeted experimental interventions, testifies to the effectiveness of Champion L.I.R.M. (Reading Intensive Speed Motor), a professional practice, forming part of the Cognitive Motor Training based on the Crispiani Method. A clinical trial, conducted before and after the intervention, on a sample of 20 children on an equivalent control group, showed an average of improvement in activation time in reading, planning motor coordination and sequential memory. The research has focused on an intensive and sequential activation of cross patterns of the lower and upper limbs, and in general praxic performance builds their “incipit” or readiness for rapid activation. We pay particular attention to four major vectors of Physio-Praxis- Vectors (namely Incipit, Fluidity, cross patterns, and rotary patterns), in intensive closed cycles of 2 or 3 days, for a total of 15 hours, working on constant and ecological rhythm. Through applying motor and coordinated sequences, we promote and activate processes, improving automatization of neural circuits and exchanges between the hemispheres. Improvement and functional gains are also extended to attention, memory, planning, self-regulation, general responsiveness.

## **B48. Exposure to natural bright light as means to boost executive functioning in young adults**

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**Keywords:** Visual attention, Sustained attention, RT, Daylight, Chronotype, Young adults

Natural light is free, ecological, safe and healthy. Exposure to bright daylight can induce an acute alerting response and improve cognitive functioning through neuromodulation of sleep-wake, circadian, physiology. The efficacy of light stimulation is dependent on the time-of-day it is administered and individual's chronotype. We explored the interaction between attentional abilities and exposure to daylight in the morning hours (compared to office light), as a function of individual's chronotype, using simple and four-choice Deary-Liewald computerized reaction time task in healthy young adults. Sleep-wake behavior (chronotype) and sleep quality were subjectively and objectively assessed using questionnaires (MEQ, PSQI) and week-long actigraphy. Each participant experienced both light conditions – daylight or office light 45 min exposure prior to RT tests – on different days of testing, in a cross-over design. Our results show that: (i) on average, when tested under office light condition, evening chronotype persons were slower in reaction time tasks as compared to non-evening persons; (ii) exposure to bright day light prior to RT testing closed the gaps in attention abilities, both simple and sustained, between the groups. We conclude that exposure to natural bright light during morning hours may selectively upregulate visual attention in the evening chronotype persons. Given that bright daylight is almost an unlimited resource, the current experiments provide a data base to model and advance the understanding of the interactions between complex behavioral phenomena, – simple and sustained attention, – and chrono-biological factors mediated by light.

## **B49. Executive functions in violent and nonviolent criminal behavior**

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**Keywords:** Executive functions, Violent crime, Non-violent crime, Miyake latent variable analysis

Executive functions (EFs) is an umbrella term for several processes and sub processes related with goal oriented behavior and decision-making strategies. However, the failure to disaggregate between different subtypes of crime and antisocial individuals can impede the identification of specific neurocognitive mechanisms associated with criminality. We examined the extent to which inhibition, shifting and updating (according to Miyake latent variable analysis of EFs) are associated with violent and non-violent crime. Fifty-two violent and 47 non-violent inmates incarcerated in three high security facilities were compared to 48 community controls without history of violence or crime. Data collection included a record review, semi-structured interview, screening for mild cognitive impairment and neuropsychological testing on a battery of EFs tasks. There was a group effect on inhibition domain, with inmates performing significantly worse than community controls. This result demonstrates a more nuanced view on the association between EFs and criminality, suggesting that impaired inhibition might be common to both violent and non-violent crimes. Therefore, not only prevention but also intervention strategies might address specific neurocognitive skills in order to improve their effectiveness.

## **B50. Executive functions and gender differences: Behavioral and anatomical data**

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**Keywords:** Executive Functions, Gender differences, Anatomical data

Previous studies have shown that individual differences such as gender-related factors may play a role in cognitive functions. However, very few studies have investigated executive functions in this perspective. An unequal structural brain maturation in the prefrontal cortex in males and females seems to play a critical role. The study aimed to investigate along which components of executive functions male and female young adults may differ, both behaviorally and anatomically. Subjects (N = 26, 11 males, age ranged 18-22) were recruited and administered a new non-immersive virtual reality assessment of executive functions known as JEF© (Jansari Assessment of Executive Function) alongside the 'classic' BADS (Behavioural Assessment of the Dysexecutive Syndrome) task. Participants were examined via magnetic resonance imaging (MRI). Males scored significantly higher than females on JEF function Creative Thinking ( $p < .01$ ) while there were not significant differences in the remaining constructs of JEF and BADS. There were positive correlations between Planning and the subcomponent Rule Shift Cards Test (BADS) ( $p < .05$ ) and between Adaptive Thinking and Rule Shift Cards Test (BADS) ( $p < .01$ ). Cortical thickness analysis showed the two groups differ significantly ( $p < .05$ ) in the superior frontal lobe, post central gyrus and paracentral area. Specifically, females have thicker cerebral cortex in these areas compared to males. On average there is a positive correlation between these three brain areas and Planning (JEF) and Temporal Judgment Test (BADS).

This study suggests that individual differences in executive function include some gender-specific factors and the brain anatomy underpinnings of executive function are not limited to the prefrontal cortex.

## **B51. Executive functions and prospective memory: clinical evidences on a multiprocess framework on planning actions**

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Keywords: Prospective memory, Working memory, Executive functions

Recent studies demonstrated the role of executive functions in Prospective Memory (PM), even though it is still debated how these processes are overlapped. Our aim was to understand the role of executive functions in PM. Thus, we developed an experimental procedure in which we manipulated the level of executive load required by cognitive tasks. Experiment 1 required a simple arithmetic activity together with a PM task to be performed at a given time (time-based condition) or following cue presentation (event-based condition). In Experiment 2 we varied the complexity of the ongoing task (a PASAT test) maintaining the same procedure of Experiment 1. We examined the effect of executive load manipulation in a patient (man, 52 y.o.) with a severe disexecutive syndrome following post-anoxic brain damage and 9 healthy participants. Patient's performance significantly differed in PM accuracy only in PASAT-time condition. The difference between simple arithmetic and PASAT task in time-based condition was statistically significant as compared to the difference observed in the control sample. No differences were found in event-based conditions. These results suggested a partial independence between executive functions and PM in tasks involving an automatic retrieval of PM intention (event based). Nevertheless, these

mechanisms seem to share resources in complex tasks requiring PM self-retrieval (time based). Our findings support a multiprocess framework, which assumes the role of controlled processes in PM under certain task conditions and emphasized the strong influence of planning, monitoring and attention abilities even in complex daily-life PM tasks.

## **B52. Hereditary and environmental factors of executive functions**

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**Keywords:** Executive functions, Wisconsin Card Sorting Test, Behavioural genetics

There is still no conclusive answer to the question of what influences the performance on the Wisconsin Card Sorting Test (WCST). Studies in the field of behavioural genetics give insight into the aetiology of individual differences by specifying the sources of variance, which can be hereditary/genetic and/or environmental. The main aim of this study was to determine the impact of additive genetic and shared and non-shared environmental factors in explaining the variance of different indicators of the WCST. The study included 404 twins of both sexes (average age = 24.7 years, SD = 7.8). Heritability was assessed using a biometric models, which included complete A (additive genetic variance), C (shared environmental variance), E (non-shared environmental variance) models of inheritance. The reduced AE model proved to be the most adequate in explaining the phenotypic variance of most WCST indicators (percentage of conceptual-level answers, number of categories, perseverative errors, perseverative answers, and non-perseverative errors). For the above indicators, the variance is shared between additive genetic influences and non-shared environmental influences, wherein genetic influence is far less dominant, ranging between 20% and 27%. This pattern of inheritance, obtained using univariate genetic analyses, indicates



low genetic conditionality of most WCST indicators used and suggests that the influence of non-shared environment stands out as the most significant source of individual differences on these measures.

## **B53. Virtual kitchen: An ecologically oriented task of executive functions assessment**

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Keywords: Executive functions, Assessment, Virtual reality

A virtual environment used artificial stimuli that can effectively replace real ones and it can be an effective tool for executive functions assessment. Executive functions are strongly involved in daily life activities and therefore the possibility to simulate some real complex activities is interesting. The aim of this study is to develop a virtual task able to assess prospective memory, complex planning and action monitoring. Twelve participants with chronic traumatic brain injury and twelve matched control participants were asked to tidy and to prepare lunch in a virtual kitchen. Some actions need to be carried out within timing constraints. In the case in which the action accomplished was not required, the system provided a feedback. Participants were also administered the Behavioural Assessment of the Dysexecutive Syndrome and a brief neuropsychological assessment. Results of the virtual task showed some deficits for executive functions in the patients examined. A performance analysis was carried out. Execution time, number, and type of errors and number of missing actions showed some peculiar difficulties in prospective memory, planning and monitoring behavior. Spearman correlation coefficients were computed between the neuropsychological measures and the virtual kitchen measures. Virtual kitchen performance significantly correlates with some of the paper and pencil tests used. Preliminary evidence from this study suggested that the virtual kitchen task may be an ecologically valid method for executive functions assessment of chronic traumatic brain injury patients. This task may be especially useful when the assessment needs are related to return home or to work.

## **B54. The executive function profile in patients with cerebellar pathology**

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**Keywords:** Executive functions, Cerebellum, Planning, Set-shifting

“Executive functions” (EFs) are a set of cognitive processes that allow to select and monitor behaviours to achieve specific goals. Although it has been proposed that the cerebellum is involved in EFs by means of specific anatomical connections with the lateral prefrontal cortex, its specific role in these processes needs to be clarified. Aim of the present study was to investigate the EFs in subjects with cerebellar pathology to characterize their profile of executive impairment. Twenty-three patients with cerebellar atrophy (CA), 18 patients with focal cerebellar damage (FCD), and 43 matched healthy controls (CT) were enrolled in the study and underwent an extensive evaluation of the EFs. A one-way Anova and Tukey’s post hoc test were performed. Moreover a principal components analysis with 3 factors (Planning, Set shifting and Cognitive Inhibition) was executed to identify possible shared process among impaired EFs tasks. Finally, in order to investigate the link between executive impairment and the pattern of cerebellar structural alterations, T1 weighted scans were also collected for voxel-based morphometry analysis and cerebellar lesion characterization. The neuropsychological assessment evidenced that CA was significantly impaired in planning tasks while FCD was significantly impaired in set shifting tasks. By using the neuroimaging analysis, the damaged cerebellar regions have been identified in CA and FCD. The structural alteration patterns have been related to the executive impairment patterns. The hypothesis that, in presence of a cerebellar pathology, different profiles of EFs alteration depend on cerebellar damage localization will be discussed.

## **B55. Selective verbal language deficits of children with Sick Cell Disease are caused by impairment of executive functions**

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Keywords: Sick Cell Disease, Cerebral infarcts, Executive functions, Naming, Semantic fluency, Phonological fluency

Children affected by Sick Cell Disease (SCD) are known to suffer from a broad- spectrum executive dysfunction related to cerebral infarcts to frontal brain areas. Verbal language deficits are also common, but the etiology of poor performance in the verbal domain is still not clear. Extension of brain injuries to language areas or environmental factors, like socio-economic disadvantage and bilingualism, could explain the poor performance in the verbal domain. The majority of children with SCD in Italy are indeed of immigrant families whose first language is not Italian. The study tests the hypothesis that the language deficits of children with SCD are selective and related to the frontal lobes functioning deficit that characterize this population. Thirty-two children with HbSS SCD from 6 to 12 years (mean age = 9.03) and 35 healthy demographically matched controls (mean age = 9.14) were administered tests of naming skills, phonological and semantic fluency, attention and EFs (inhibition and planning skills). Nine children with SCD showed Silent Infarcts in the White Matter at the borderzones of the Middle Cerebral Artery. Results show significant differences between patients and controls in inhibition and planning ( $p = .001$  and  $.001$ ) and in phonological fluency ( $p = .004$ ). The poorer verbal performance of children with SCD is not associated to visible brain damage to language areas, but is explained by the children's inhibition skills. The results suggest that selective language problems may occur in children with SCD as a consequence of EFs deficits, likely due to hypoxigenation of frontal areas.

## **B56. Sex differences in social and non-social inhibitory control**

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**Keywords:** Response inhibition, Automatic imitation, Sex differences, Cognitive control

Automatic imitation (an involuntary tendency to copy the behaviour of others) is an important part of our social interactions. Although situational and contextual antecedents of imitation have been studied, research on how processes underlying imitation vary across individuals, especially between sexes, is limited. Recent evidence suggests that when using a reaction-time measure of automatic imitation, females showed a greater level of interference when inhibiting automatic imitative tendencies compared to males (Butler, Ward, & Ramsey, 2015). However, whether this difference between the sexes is domain-general or solely tied to imitative control is as yet unclear. Using a large sample ( $N = 217$ ; 113 females), the current study tested whether performance on a non-social inhibitory control task (i.e. the Flanker task) and an automatic imitation task differed between the sexes. Further, in order to minimise the contribution of spatial compatibility in the automatic imitation task, we positioned the stimuli orthogonal to the response hand. Results demonstrated a larger interference effect for females than males in the automatic imitation task, but not on the flanker task. In addition, a correlational analysis showed no evidence for a relationship between the interference effects of the two tasks. Taken together, these results provide evidence for partially distinct mechanisms of inhibitory control between the flanker and the automatic imitation task as a function of sex. To extend and complement this behavioural research, an fMRI experiment ( $N = 50$ ) is currently exploring the interplay between domain-general and domain-specific neural architectures in automatic imitation and how these differ between the sexes.

## **B57. Measuring Executive Functions in Children: The importance of processing speeds and scoring methods**

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**Keywords:** Executive function, Processing speed, Performance indices, Scoring protocols, Working memory

Many studies have examined the structure of executive functions in children using latent variable analysis. Commonly the factors measured are inhibition, shifting, and working memory (WM), and studies have also extended this to the relationship with higher-level cognitive abilities (HLC) such as reading and mathematics. However, findings across studies vary, with one, two, and three factor models arising. This study considers processing speed, and scoring protocols as explanations for the disparity in findings. Controlling for individual differences in processing speed and using both speed and accuracy scores for processing and recall, this study examined the relationship between a three-factor model of executive function (inhibition, task-switching, WM) with three measures of HLC (reading, mathematics, non-verbal reasoning). Ninety-five children were assessed at approximately seven years of age. Three computer-based WM measures were designed for the study, allowing individual processing speeds to be calculated a priori and applied in the administration of the tasks. Performance indices for processing time and accuracy, and recall time and accuracy were then extracted and used to predict performance on three HLC tasks. Processing speed and recall accuracy in the WM tasks were found to predict HLC. No measures of inhibition or task-switching were found to be related to each other or to HLC. The findings suggest that the structure of executive function in children, and its importance in HLC is less about discrete executive abilities, and related more to fundamental processing and storage capacities. The importance of administration and scoring methods when measuring executive function is discussed.

## **B58. Alcohol does not affect the intentional inhibition of action**

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Keywords: Voluntary action, Intentional inhibition, Readiness potential, Alcohol, Ideomotor

The capacity to intentionally refrain from certain actions constitutes a core attribute of self-control. The specific mechanisms underlying the intentional suppression of ongoing actions inhibition remains a controversial issue. Participants engaged in a novel motor-tracking task and decided when to disengage from tracking at will, while EEG registered their brain activity. We observed a Readiness Potential (RP) not only just before voluntary action initiation (as typically found), but also prior to action inhibition. This finding suggests similar neurophysiological mechanisms underlying intentional action initiation and intentional action inhibition. Hence, the RP does not reflect motor preparation per se, but rather the processes involved in the formation of an intention, such as the ideomotor anticipation of the consequences of an intended (non)action. A second study replicated these findings; moreover, contrary to expectation, the RP was in no way affected by acute alcohol consumption.

## **B59. Can continuous positive airway pressure treatment restore executive functions in obstructive sleep apnea? A systematic review**

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Keywords: Obstructive sleep apnea, CPAP, Cognitive functions, Neuropsychological tests

Obstructive sleep apnea (OSA) is a common sleep disorder characterized by intermittent hypoxia that induces frequent arousals and sleep fragmentation. Patients with OSA often report cognitive impairments, in particular in executive functions. Here, we performed a systematic review of the literature to evaluate whether continuous positive airway pressure (CPAP) treatment may restore executive functions in OSA patients. First, we targeted study comparing executive functions before and during ongoing CPAP treatments. Second, we assessed whether observed improvements were due to treatment per se or to other factors. Thirty-two studies were analyzed. In these studies, cognitive assessments during ongoing treatment were conducted 1 week to 6 months after baseline evaluation. Twenty-two studies reported improvements with low to moderate effect sizes in executive functions. However, several of these positive results could be considered artifacts due to practice effects on the neuropsychological tests used. Only 10 out of these 22 studies compared the effect of CPAP against placebo or conservative care treatments, with 8 of them showing a small, but specific improvement due to CPAP on at least one executive function test. All in all, the heterogeneity of the results and the lack of valid test-retest instruments does not clearly allow to conclude that CPAP in OSA patients can restore executive functions. These results highlight the need to develop more sensitive instruments to assess treatment-dependent changes in executive functions in OSA patients.

## **B60. Impairment and Heterogeneous Executive functions in children with Attention Deficit and Hyperactivity Disorder (ADHD)**

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Keywords: Executive Functions, Attention Deficit and Hyperactivity Disorder, Inhibition, Divided Attention, Updating, Attentional Shifting

In recent years, the interest in Attention Deficit and Hyperactivity Disorder (ADHD) and its relation to deficits in working memory and more specifically the different executive functions has grown, to the point of confirming that these are quite frequent in this disorder. The aim of this study was precisely to explore differences in executive functioning of working memory in 4th grade Primary school children with and without ADHD, introducing rigorous control measures in the tests used. Four executive functions were analyzed: divided attention, updating, attentional shifting and inhibition, measured through four tasks, the dual-task paradigm (digits and box-crossing), the N-Back task, the Trail Making Test (TMT) and the Stroop task, respectively. The results showed that participants with ADHD, compared with controls, exhibited a smaller verbal memory span as well as deficits in the attentional shifting and updating functions. However, a similar performance for the executive function of inhibition was found for both groups of participants. Finally, an unexpected result was obtained with regard to the role of divided attention, as children with ADHD were less impaired when performing the double task than participants in the control group.

## **B61. Executive attention processes: Energization and progressive supranuclear palsy**

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Keywords: Energization, Attention, Dynamic aphasia

Energization is the process of initiating and sustaining a response over time. It has been described as one of three key “executive” attentional control processes associated with the frontal lobes. Energization deficits have previously been demonstrated using verbal and nonverbal fluency tasks. Recently an energization impairment accounted for the paucity of spontaneous speech in a patient with dynamic aphasia, in the context of the neurodegenerative condition of progressive supranuclear palsy (PSP). The aim of this study was to investigate the process of energization in patients with PSP. Patients with



PSP ( $n = 4$ ) and healthy older adults ( $n = 29$ ) were assessed on cognitive baseline tests of attention, language and executive function including verbal fluency, and an experimental task from the RoBBIA battery to specifically investigate the process of energization. As expected, subjects with PSP were reduced relative to controls on some cognitive baseline measures (e.g., executive function and attention), which is consistent with known deficits in PSP. On the RoBBIA energization task, subjects with PSP were slower than controls overall, and showed a clear pattern of energization deficits consisting of fluctuations in sustained attention and response initiation over time. Healthy controls did not show this fluctuation pattern. Overall, executive attentional mechanisms like energization are critical for a range of cognitive functions such as spontaneous speech and other goal-directed tasks. Understanding how these underlying processes operate in healthy ageing and are impaired in pathological ageing, such as in the neurodegenerative condition of PSP, has theoretical and practical implications.



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