Abstract: Sleep loss is a common occurrence and has recently come under scrutiny as the determining cause of many catastrophic events. Previous studies (Harrison & Horne, 2000) have shown that sleep deprivation can have deleterious effects on cognitive performance and decision-making, however the neural correlates of sleep deprivation are not yet fully understood. The Multi-Source interference task (MSIT) combines elements of three different tasks (Stroop task, Eriksen flanker task, and Simon effect) to induce cognitive interference and robust activation of the dorsal anterior cingulate cortex (dACC) and dorso-lateral prefrontal cortex (DLPFC) (Bush et al., 2003). Previous studies have shown inconsistent findings when testing the effects of acute sleep loss on executive function (Drummond et al., 2006; Kilgore et al., 2006; Cain et al., 2011). The aim of this study was two-fold: (1) to determine how sleep deprivation affects executive function using the MSIT and (2) to use functional MRI (fMRI) to identify the neural regions that are preferentially effected during sleep deprivation, using the general linear model (GLM) and multivoxel pattern analysis (MVPA) analyses.
Study volunteers performed the MSIT while undergoing three fMRI sessions. Each session consisted of three MSIT runs. In the 1st session, subjects achieved three nights of normal sleep (greater than 7 hours of sleep per night). During the 2nd session, subjects achieved complete sleep deprivation for at least 24 hours. In the final session, subjects returned after 2 nights of recovery sleep.
Subjects showed delayed reaction times in the neutral condition during sleep deprivation compared to their initial scan ($p < 0.05$). The recovery session eliminated the sleep deprivation delay ($p < 0.05$).
MSIT performance slowed significantly during acute sleep loss conditions and readily reversed with recovery sleep, indicating that sleep deprivation does have acute yet transient effects on executive function. These results support the notion that total sleep deprivation affects both sustained attention and response inhibition. The improvement from baseline reaction times after sleep recovery may indicate a practice effect not previously described using the MSIT. These readily reversible effects should be explored further in comparison to pathological conditions characterized by irreversible executive functioning deficits, such as stroke and traumatic brain injury.

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Poster

573. **Working Memory and Executive Function III**

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Title: Neural representation of rules at different hierarchical levels

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Abstract: In everyday life, humans use rules to organize their thoughts and actions in order to achieve specific goals (Bunge & Wallis, 2007). For simple situations, single rules can be used to link a sensory stimulus (the traffic light is green) to its appropriate response (cross the road). More complex situations, however, require the application of multiple rules organized in hierarchies, where high level rules influence the selection or application of lower level rules. Previous studies have demonstrated that Prefrontal Cortex (PFC) is one of the key areas underlying rule processing and control of action. However, it is still unclear whether distinct brain regions within PFC systematically encode qualitatively different task features.
In the present study we investigated whether different features defining a complex rule set are represented in different brain areas depending on the level of control they enforce. To this purpose, we devised an experiment in which participants (N = 20) learnt complex rule sets composed by rules at two different levels of control: low (e.g., "if you see a banana, then press left") and high (e.g., "If you see a star, then only consider red targets"). The task required participants to retrieve, maintain, and apply two rule sets (one low and one high level) to target stimuli. At the beginning of each trial two cues associated with low (or high) level rules were displayed, followed by a delay (delay 1). Then a second pair of cues standing for high (or low) level rules were presented followed by a second delay (delay 2), after which the target was shown. Participants had to apply all the rules to the target stimuli and respond accordingly. The paradigm allowed us to: (i) independently assess the encoding of high and low level rules, (ii) evaluate the difference between the encoding of the two types of rules (comparing high vs. low level rule representations during delay 1, when only one type of rule was maintained), and (iii) decode rule integration (by comparing rule representations during delay 1 vs. delay 2, in which the two levels of rules had to be integrated in order to respond).
We applied multivariate decoding analysis (e.g., Haynes et al., 2007) to functional magnetic resonance imaging data to perform the above-described comparisons. Behavioral as well as

preliminary decoding results suggest that rules at different levels of abstraction are indeed processed differently in distinct brain regions within a large-scale brain network comprising parietal and prefrontal areas.

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Poster

573. **Working Memory and Executive Function III**

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Title: The brain's response to cognitive demand under drug-induced Impairment: A topiramate study

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Abstract: Many CNS drugs negatively impact cognition. How the brain copes with drug-induced impairments is not clear. Understanding this problem is important to explain inter-individual variability in patients' response to these drugs and to optimize therapeutic strategies. We examined this problem with respect to the antiepileptic drug topiramate (TPM) which has also been indicated in a number of other conditions. Healthy volunteers were administered a single, 100-mg oral dose of topiramate in a double-blind, randomized, placebo-controlled, crossover design. High-density scalp EEG was recorded while the volunteers performed a modified Sternberg working memory task with three levels of memory load (1, 3, and 5). Memory retrieval-related ERPs were analyzed across the whole brain. During baseline and placebo conditions, the central-frontal region showed strong memory load modulation; no memory load modulation was observed in bilateral frontal regions. In contrast, during the TPM condition, the memory load modulation in the central-frontal region was significantly reduced but additional brain regions showed sensitivity to memory load, including the bilateral frontal regions. By comparing the ERPs between baseline, placebo and TPM conditions for a given memory load, we further found that during the TPM condition, the ERPs from the central-frontal region were enhanced for low memory load but not for high memory load, whereas the ERPs from the bilateral frontal regions were enhanced for high memory load but not for low memory load. These findings suggest that the brain employed a compensation mechanism by recruiting