Role of feedback connections for attention and learning

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Most theories hold that early visual cortex is responsible for the local analysis of simple features while cognitive processes take place in higher areas of the parietal and frontal cortex. I will illustrate cases where early visual cortex directly contributes to visual cognition - in tasks where subjects reason about what they see. The early, feedforward-driven neuronal responses in the visual cortex are informative about the stimulus, but later response components depend on feedback from higher visual areas. I will discuss new evidence supporting the hypothesis that feedback the modulation of activity in early visual areas has a causal role in cognition. The modulatory influences allow the early visual cortex to act as a multiscale cognitive blackboard for read and write operations by higher visual areas, which can thereby efficiently exchange information.

I will also discuss how feedback connections from the response selection stage to early processing levels enable powerful learning rules in the brain, by restricting plasticity to those synapses that are involved in the stimulus-response mapping. These new learning rules are biologically plausible and yet as powerful as the non-biological rules used to train artificial deep networks. The results, taken together, provide new insights in the role of visual cortex as a cognitive blackboard which supports the execution and learning of mental programs.