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“What does prefrontal cortex "know" about visual motion used in discrimination tasks?”

Perceptual decisions during visual discrimination tasks often require subjects to compare two or more sequentially presented stimuli. During such tasks the stimuli not only have to be processed, but also retained in memory and the comparison between the remembered and the current stimulus has to be performed. We are interested in characterizing the cortical circuitry sub-serving successful execution of such discrimination tasks. We focused on speed and direction of visual motion and compared the behavior of neurons during such tasks in two interconnected cortical regions, motion processing area MT and a region associated with executive control and working memory, prefrontal cortex (PFC). During these tasks, the monkeys compared either directions or speeds of two moving random-dot stimuli, sample and test, separated by a brief memory delay.

During direction discrimination task, many PFC neurons showed robust direction selectivity (DS) in response to the sample and the test, and these responses were modulated by motion coherence in a way reminiscent of neurons in area MT. During a task requiring discriminating stimulus speed and ignoring its direction, the same PFC neurons showed tuning for stimulus speed, resembling speed selectivity in MT. The nature and the temporal dynamics of these motion selective PFC responses supported their bottom-up origins. This response selectivity was task-driven and DS was reduced on trials when the monkey's attention was redirected to stimulus speed or during passive fixation. The nature of this dependence of response selectivity on task demands point to functional specialization among neurons in prefrontal cortex, with putative inhibitory interneurons selectively gating sensory signals when speed rather than direction became behaviorally relevant.

During the memory delay, both MT and PFC neurons carried reliable DS signals during direction discrimination task, although in individual neurons such signals were largely transient and were rare late in the delay. Similarly, speed selective delay signals in PFC during speed discrimination were also largely transient. The transient nature of delay activity suggests that the contribution of PFC neurons to stimulus maintenance, if any, could only be accomplished at the population level.

During the comparison phase, responses to the test in both areas were modulated by the remembered stimulus, reflecting access to the remembered sample. In the direction task, comparison-related signals in PFC were in the form response suppression on match trials, which appeared 100ms later than similar signals in MT, pointing to MT as a likely source of comparison signals. In summary, these data provide evidence that during motion discrimination tasks, neurons in areas MT and PFC make unique contributions to different task components and are likely to be functionally linked. MT neurons process visual motion and pass this information as bottom-up signals to PFC. PFC, in turn, faithfully represents this sensory information but only when it is behaviorally relevant, pointing to PFC neurons' active participation in processing of sensory signals, perhaps, by supplying top-down signals to visual neurons about the rules governing the use of sensory stimuli. These neurons also carry decision signals likely to be based on sensory comparison signals probably supplied by area MT.

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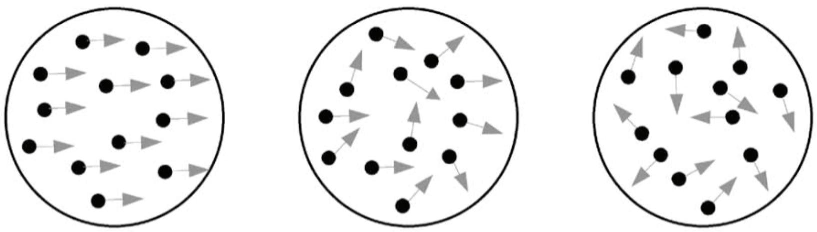

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