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A subcortical source of visual input to the frontal eye field

Marc Sommer; Robert Wurtz

+ Author Affiliations

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Abstract

Many neurons in the frontal eye field (FEF) exhibit visual responses and are thought to play important roles in visuosaccadic behavior. The FEF, however, is far removed from striate cortex. Where do the FEF's visual signals come from? Usually they are reasonably assumed to enter the FEF through afferents from extrastriate cortex. Here we show that, surprisingly, visual signals also enter the FEF through a subcortical route: a disynaptic, ascending pathway originating in the intermediate layers of the superior colliculus (SC). We recorded from identified neurons at all three stages of this pathway (n=30–40 in each sample): FEF recipient neurons, orthodromically activated from the SC; mediodorsal thalamus (MD) relay neurons, antidromically activated from FEF and orthodromically activated from SC; and SC source neurons, antidromically activated from MD. We studied the neurons while monkeys performed delayed saccade tasks designed to temporally resolve visual responses from presaccadic discharges. We found, first, that most neurons at every stage in the pathway had visual responses, presaccadic bursts, or both. Second, we found marked similarities between the SC source neurons and MD relay neurons: in both samples, about 15% of the neurons had only a visual response, 10% had only a presaccadic burst, and 75% had both. In contrast, FEF recipient neurons tended to be more visual in nature: 50% had only a visual response, none had only a presaccadic burst, and 50% had both a visual response and a presaccadic burst. This suggests that in addition to their subcortical inputs, these FEF neurons also receive other visual inputs, e.g. from extrastriate cortex. We conclude that visual

activity in the FEF results not only from cortical afferents but also from subcortical inputs. Intriguingly, this implies that some of the visual signals in FEF are pre-processed by the SC.

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Footnotes

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