Comparison of the Discharge Characteristics of Brain Stem Omnipause Neurons and Superior Colliculus Fixation Neurons in Monkey: Implications for Control of Fixation and Saccade Behavior

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Comparison of the discharge characteristics of brain stem omnipause neurons and superior colliculus fixation neurons in monkey: implications for control of fixation and saccade behavior. J. Neurophysiol. 79: 511–528, 1998. Fixation neurons (SCFNs) in the rostral pole of the superior colliculus (SC) and omnipause neurons (OPNs) in the nucleus raphe interpositus (rip) in the pons share similar discharge properties. Both types of neurons discharge tonically during periods of visual fixation and pause for saccadic eye movements, and their activation by electrical stimulation suppresses saccade generation. On the basis of these similarities and the projection from the rostral SC to the rip, it was hypothesized that SCFNs provide a major excitatory input to OPNs. We investigated the role and relationship of SCFNs and OPNs with respect to both fixation behavior and saccade generation by comparing their activity recorded in the same monkeys performing a gap saccade task. In this task, the central fixation point was extinguished 200 ms before the presentation of an eccentric saccadic target, and the discharges of OPNs and SCFNs were contrasted during visual fixation, nonvisual (gap) fixation, and saccade generation. During visual fixation, the mean discharge rate of OPNs was higher and more regular than that of SCFNs. During the gap period, SCFNs decreased their discharge rate before target appearance, whereas no change in discharge rate was observed in OPNs. For both SCFNs and OPNs, the activity level before target appear- ance was not correlated to saccadic reaction time. In contrast to SCFNs, several OPNs responded with a transient phasic increase in discharge immediately after the target presentation. Before their saccade-related pause, there was a gradual reduction in the activity of SCFNs, whereas OPNs had an abrupt cessation of discharge. SCFNs paused earlier than OPNs, but the OPN pause onset was better synchronized to saccade onset than the SCFN pause onset. OPNs resumed firing after their pause in activity earlier than SCFNs, and the OPN pause end was better synchronized to saccade end than the SCFN pause end. These physiological data reveal differences in the discharge properties of SCFNs and OPNs that are irreconcilable with the hypothesis that the discharge pattern of OPNs reflects simply the excitatory input from SCFNs. It is most likely that additional inputs to OPNs compensate for the reduction in discharge of SCFNs during these periods.