In a simple visual detection task in which a subject is instructed to look straight ahead and to make a saccadic (rapid) eye movement to a brief visual target of varying contrast at a peripheral location, one astounding feature of the task is a large variability of saccadic latency, a time delay from the target onset to saccade onset. Although various models of processes underlying behavioral variability have been proposed, roles of neural activity in this simple detection task have not been fully understood. The goal of the current study was to characterize the relationship between the stimulus contrast and saccadic latency distribution in the monkey and to examine the relationship between measures of neural activity in the primary visual cortex (V1) and saccadic latency. Four macaque monkeys were trained for juice reward to fixate on a central target and then saccade to a Gabor target (sinusoidally-modulating luminance target confined within a circular area) of varying contrast and orientation that was briefly appeared at one of four peripheral locations with an equal probability. There were systematic and consistent relationships between the target contrast and saccadic latency; the distribution of saccadic latency for each contrast was positively skewed and the mean and variance of saccadic latency decreased as the stimulus contrast increased.

In two of these monkeys, we recorded the neural responses of 104 single neurons in the V1 while they made saccades to the Gabor stimuli matching the receptive properties presented at one of four locations including the receptive field location. In as much as 74% of the cells, significant positive trial-by-trial partial correlation between saccadic latency and the onset of neural response was found at a fixed stimulus contrast. Much weaker and in a time-dependent manner, but significant negative correlation between saccadic latency and the magnitude of V1 neural response was found in 38% of the cells. Thus, the neural latency was a better predictor for saccadic latency than the firing rate was. These correlations were observed at the very early phase of neural responses, indicating that the underlying mechanism was not attributable to horizontal connections within the V1 or feedback connections from the higher visual areas. Potential sources of the V1 activity variability, such as baseline activity or eye position at the time of stimulus presentation and the higher cognitive functions including attention or learning effect could not explain the present results.

The results obtained in the current study indicate that for a majority of V1 neurons the correlation between V1 activity and saccadic latency is direct, suggesting that the variability in V1 activity and saccadic latency are causally linked. To our knowledge, this is the first study to determine the correlation between V1 neural response and RT on trial-by-trial basis.

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