Supporting Information

Yttri et al. 10.1073/pnas.1220508110

SI Results

Laterality of Effects in Dorsal and Ventral Lateral Intraparietal Area. Although dorsal lateral intraparietal area (LIP; LIPd) and ventral lateral intraparietal area (LIPv) have been anatomically distinguished for decades (1–3), functional distinctions have emerged only recently (4–6). For example, it was recently reported that LIPv inactivation causes deficits in a covert visual search task whereas LIPd inactivations does not (3). From this, one might expect that lesions of LIPv, but not LIPd, would cause supramodal impairment, that is, impairments of movement regardless of effector, including dissociated reaches. In fact, by using the method we developed to image the location of injections, we found that dissociated reaches were unaffected by lesions in either area (Table 2). We did, however, find differential effects in the two areas, depending on the visual hemifield of the target (Fig. S1 and Table 2). LIPd inactivation significantly delayed the onset of saccades and coordinated reaches to targets in either hemifield (biased toward the contralateral hemifield; $P = 0.08$), whereas LIPv inactivation exclusively affected saccades and coordinated reaches to targets in the contralateral hemifield.

Combining Error and Reaction Time Effects Into a Single Measure. Inactivation affects saccade reaction time (RT) and error rate (Fig. 1). We wished to combine these two effects into a single measure. For this, we applied the concept of the speed–accuracy tradeoff. In control sessions, there was a reliable relationship between RT and error rate (Fig. S2). The relationship between the speed and the accuracy of a response is referred to as a speed–accuracy tradeoff, and is commonly observed in normal behavior of humans and monkeys (7, 8). We used RT and error rate as proxies for speed and accuracy. In our saccade task, RT is the major determinant of response time, and error rate is related to accuracy. In the control data, we find that the tradeoff (slope of straight lines in Fig. S2) is a ∼1-ms decrease in RT per 1% increase in error, for all types of movements (details in legend to Fig. S2). This ratio, obtained from control sessions, provides us with an exchange rate for RT and error rate, and allows us to combine these two disparate measurements into a single measurement of performance.

The result is equivalent to asking what the RT would have been if the speed–accuracy tradeoff had been "set" to zero errors, and assumes that the speed–accuracy tradeoff itself is not changed as a result of the inactivation. We define an "adjusted RT" as the raw RT minus the error rate times the aforementioned slope. Notice that the adjusted RT effect can be larger or smaller than the unadjusted RT effect, depending on whether error rate increases or decreases as a result of the lesion. Finally, we make no claim that animals pursue a strategy of moving more slowly to reduce error rate, either in control or experimental sessions.

The use of adjusted RT changes neither the pattern nor the absolute significance (whether P values were greater or less than 0.05) of our results. However, when changes in error rate are taken into account, the effects of inactivation on saccades and reaches becomes almost identical: 7.8 and 8.0 ms for coordinated and dissociated saccades, respectively, and 7.9 ms for coordinated reaches. The adjusted RT effect for dissociated reaches was −0.1 ms. Thus, although the pattern of significance does not change, the adjusted RT analysis reveals that the effects of LIP lesions on saccades and coordinated reaches are remarkably similar. This supports the conclusion that the effect the lesion on coordinated reaches is an indirect result of the effect on saccades, revealing the operation of an active eye–hand coordination mechanism that lies outside of and downstream from LIP.

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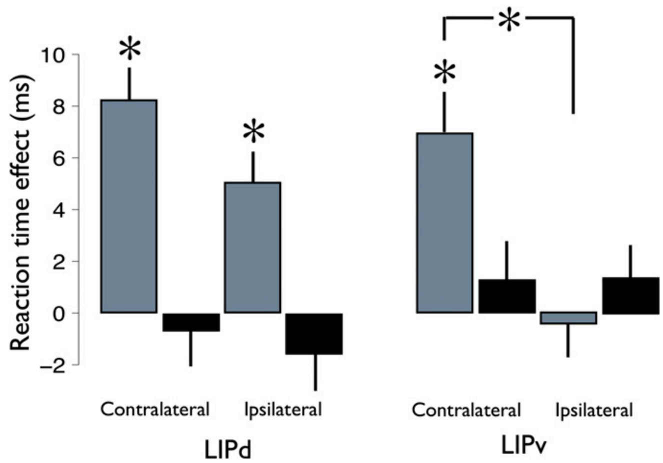

Fig. S1. Effects of inactivation of LIPd and LIPv on dissociated saccade (gray) and reach (black) RTs. Results are further separated for movements into the contralateral and ipsilateral visual hemifields. (*Significant at $P < 0.05$, inactivation vs. control.) Bracket represents significant difference between movements into the contralateral and ipsilateral hemifields.

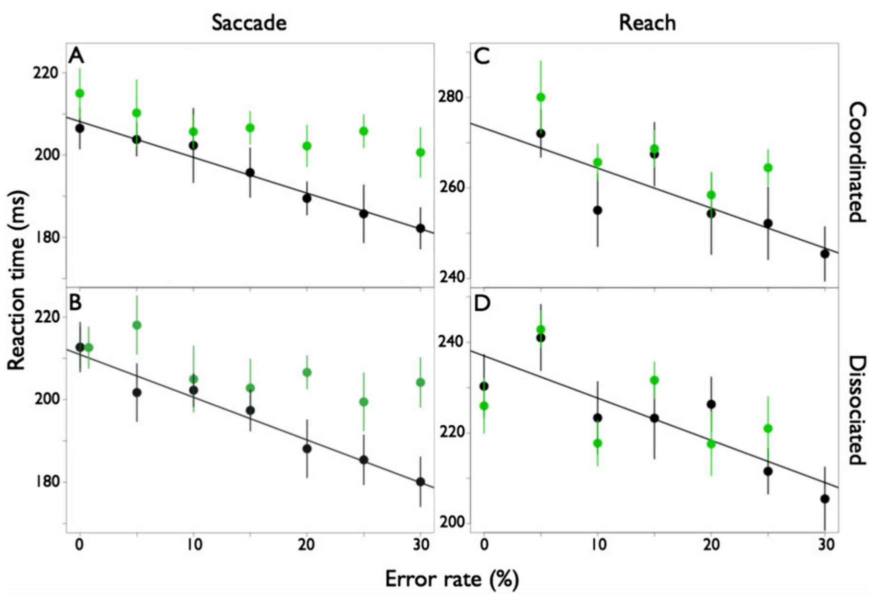

Fig. S2. Speed–accuracy tradeoff for (*A* and *B*) saccade and (*C* and *D*) reach data. To combine RT and error rate into a single, comprehensive performance measurement, we binned the data from each session based on error rate, and then plotted each bin's mean RT for control (black) and inactivation (green) data. Data from coordinated movement trials (*Upper*) and dissociated movement trials (*Lower*) are shown. For some bins, there were no data. The solid lines are least-squares regression fits for the control data. The saccade data show a clear inverse relationship, or speed–accuracy tradeoff, that is well fit by a straight line. We also used a straight line to fit the reach data. For coordinated saccades, each additional 1% of error was associated with a 0.87 ms decrease in RT (Pearson correlation coefficient $r = -0.98$; $P = 0.00006$). For coordinated reaches, the value was 0.88 ms ($r = -0.83$; $P = 0.04$). For dissociated saccades and reaches, the respective values were 1.0 ms ($r = -0.99$, $P = 0.0001$) and 0.93 ms ($r = -0.86$; $P = 0.01$). Every inactivation data point (green) for saccades (dissociated or coordinated) and for coordinated reaches lies above the corresponding control data point, indicating a decrease in performance (one data point is at the same level). In contrast, for dissociated reaches, half the inactivation data points lie above the controls and half lie below, indicating no net effect on performance.

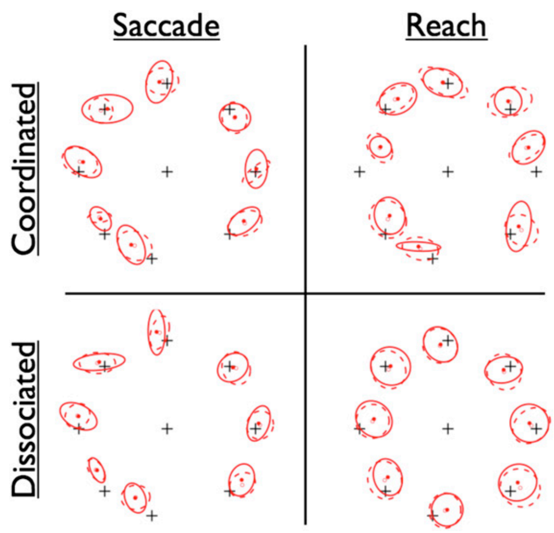

Fig. S3. Accuracy and endpoint scatter for movements to each target. The 95% confidence ellipses for the endpoints of coordinated (*Upper*) and dissociated (*Lower*) saccades (*Left*) and reaches (*Right*) are plotted. Control data are denoted by dashed lines and a hollow central point designating the mean movement endpoint. Inactivation data are denoted by solid lines and a filled central point. Crosses represent the initial fixation point and the eight targets, each 20° away from the initial fixation point. The contralateral field is displayed on the right of each plot. The bottom target is displaced by 10° so that the view of the target was not obstructed by the animal's arm.

Table S1. Mean RTs for control sessions and mean RT effects for inactivation sessions by monkey and movement type

Monkey (side inactivated)	No. (type) of experiments	Saccades, ms				Reaches, ms			
		Coordinated		Dissociated		Coordinated		Dissociated	
		Control	Effect	Control	Effect	Control	Effect	Control	Effect
Q (left)	11 (coordinated)	190.6*	4.6*	201.9†	4.2†	265.2*	6.8*	—	—
W (left)	5 (coordinated)	212.8†	8.7†	217.4†	8.6†	285.8†	11.4†		
S (left)	7 (dissociated)	—	—	208.4†	7.6†	—	—	234.8	−0.7
G (right)	15 (dissociated)			198.7*	4.6*			225.0	0.8
G (right)	2 (both)	185.6*	3.0*,‡	201.3	4.5§	252.8*	6.4*,‡	228.0	−1.7

All animals performed dissociated saccades, three performed coordinated movements, and two performed dissociated reaches. Saccades were significantly delayed in each of the four animals, and coordinated reaches were delayed or showed a trend toward a delay. In contrast, dissociated reaches were not delayed in either of the two animals tested. Splitting the data by animal reduces the number of data points and thereby reduces significance levels compared with Tables 1 and 2.

*$P < 0.05$ and †$P < 0.10$, two-tailed *t* test. To directly compare effects in a single animal and within a single session, monkey G performed both coordinated and dissociated reaches in each of two experimental sessions ("both"). The results match the data from the other sessions. In particular, coordinated reaches were significantly delayed ($P < 0.05$) in both sessions, whereas dissociated reaches were not delayed in either session.

‡Significant effects in both of the two individual sessions.

§Significant effect in one of the two individual sessions.