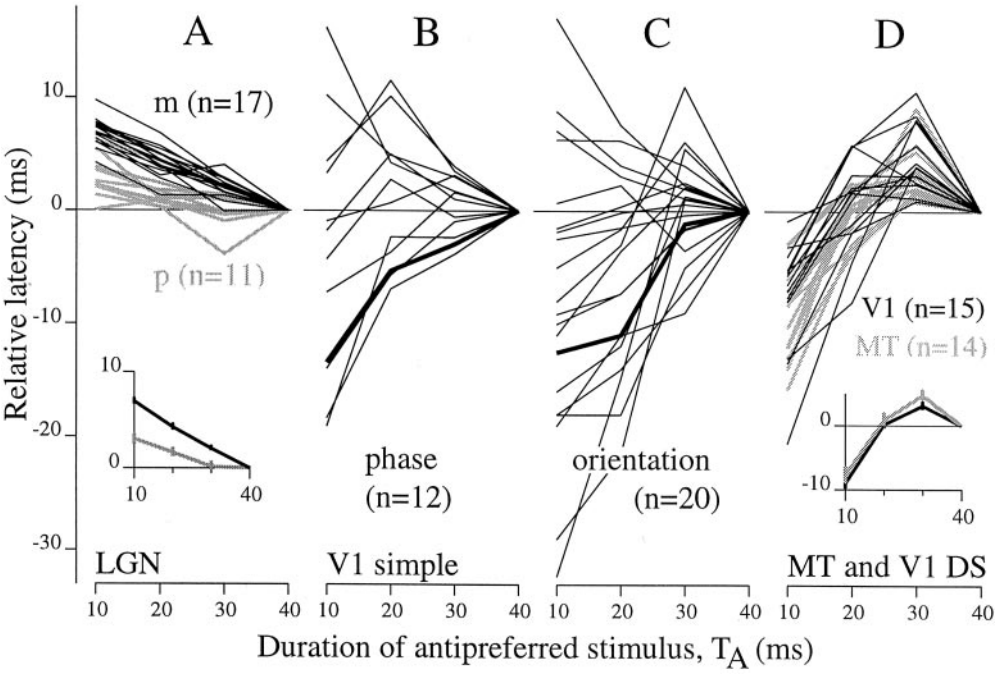

Figure 11. Summary of duration dependence of latency across cell classes. Relative latencies for 5% rise-to-peak are plotted against the duration of the antipreferred stimulus, T_A, that preceded the AP transition. All values are given relative to the value for $T_A = 40$ msec. *A*, Each *line* emanating from the point (40,0) shows data for a p-cell (*gray lines*) or an m-cell (*black lines*). For nearly all LGN cells, latency increased as T_A decreased. The average relative latencies are plotted for p-cells (*gray line*) and m-cells (*black line*) in the *inset* (error bars show ±1 SEM). m-cells on average had significantly longer relative latencies (*t* test; $p < 0.00001$; $7.0 > 3.7$ msec; $T_A = 10$ msec). Results shown here are for counterphase stimuli. Cell counts appear in *parentheses*. *B*, Similar data are plotted for V1 simple cells tested with counterphase stimuli. These plots show that V1 had more diverse behavior than the LGN. Latency could increase or decrease as T_A decreased. The *thick line* corresponds to the example data in Figure 10*B* for which the latency decreased with T_A. *C*, Similar to *B*, but for V1 simple cells tested with the orthogonal orientation stimulus. The *thick line* here and in *B* show data collected from the same cell. *D*, For V1 complex cells (*black lines*) and MT cells (*gray lines*) tested with the direction stimulus, response latency first increased and then decreased as T_A was reduced from 40 to 10 msec. The *inset* shows the average relative latency for MT cells and V1 complex DS cells.

orientation stimulus showed a similar diversity (*C*). Complex DS cells in V1 and cells in MT that were tested with the direction stimulus showed behavior similar to each other (Fig. 11*D*) and were less diverse than V1 simple cells. There was an initial increase followed by a larger decrease in latency as T_A decreased from 40 to 10 msec. Average changes in latency are plotted in the *inset* in *D*. The data in Figure 11 show that the signals from preferred and antipreferred stimuli do not interact in the same way across cortical areas and cell types, at least at the time scale of tens of milliseconds.

The changes in onset latency with antipreferred pulse duration can be related back to our estimates of Δ_{AP} reported in Figure 4. Those results were derived from responses to 50 msec sequences beginning with 30 msec of A; therefore, they are most comparable with the results for $T_A = 30$ or 40 msec here. For LGN cells, this implies that Δ_{AP} for shorter (10–20 msec) antipreferred pulses would be on average larger than reported in Figure 4*C*. Interestingly, the larger increase in onset latency for m-cells compared with p-cells for short A pulses (Fig. 11*A*) appears to compensate for the shorter Δ_{AP} value for m-cells shown in Figure 4*C*. In fact, the average values of Δ_{AP} computed using the onset time for the $T_A = 10$ msec responses were 12.5 and 12.3 msec for p- and m-cells, respectively (SD 3.1, $n = 11$ for p-cells, SD 3.0, $n = 17$ for m-cells). For V1 complex DS cells and MT cells, the change in onset latency from $T_A = 30$–40 msec to $T_A = 10$ msec was approximately −10 msec (Fig. 11*D*), which is equal but opposite to the mean Δ_{AP} reported in Figure 4*F* and *G*. Thus, the early response onset after a 10 msec pulse of antipreferred motion (Fig. 10*C*, *thin solid line*) occurs very close to the response offset time computed previously from the PA transition. On average Δ_{AP} is only ~3 msec for V1 and MT when computed using the onset time for $T_A = 10$ msec. This suggests that 10 msec of motion reversal is too brief to activate the mechanism by which the antipreferred stimulus delays response onset.

Finally, for the stimulus sequences just examined, two factors were changing at once: the duration, T_A, of A and the duration, T_P, of P that preceded A. A set of control sequences in which T_P was held constant at 30 msec are shown in the *gray inset* in Figure 10*D*. The rightward and then leftward shift in the latency of the AP responses to these stimuli (Fig. 10*D*, *gray arrows*) was similar to that observed in *C*. The longest stimulus sequence (100 msec) occurred only 12 times. The infrequent occurrence of the longer sequences made them less useful than the constant length sequences (Fig. 10, *top inset*) for accurate estimation of response trends. Nevertheless, the shifts in latency for the longer sequences were qualitatively similar to those for the shorter sequences for the cell types described here. This is not to say that the sequence before the antipreferred pulses had no significant effect on responses. The sequence history affected the responses, but a full account of this is not attempted here. We simply demonstrate that onset latency showed history dependence that characterized and differentiated between cell classes.

DISCUSSION

We found that nearly all neurons in the LGN, V1, and MT responded more rapidly to a stimulus transition from preferred to antipreferred than to the opposite transition. The generality of this observation might be questioned because our rapidly changing stimulus differs from commonly used stimuli that flash on for ~1 sec after several seconds of homogeneous background. Published data for standard stimuli, however, suggest that Δ_{AP} is positive for cat cortical neurons (von Baumgarten and Jung, 1952, their Fig. 3) and ranges from 3–9 msec for cat LGN cells (Coenen et al., 1972, their Table 1; Mastronarde, 1987a, his Table 1; Humphrey and Weller, 1988; Saul and Humphrey, 1990). Data of Adrian and Matthews (1927, their Fig. 5) and of Hartline (1938) suggest that Δ_{AP} is positive in the early visual systems of other vertebrates as well.