

Figure S1. Anatomical and behavioral details, Related to Figure 1.

(A) *Top*: Representative tissue stained for CO showing the rostral to caudal progression of VP (left) and VL (right). VP was differentiated from the surrounding nuclei by its dark appearance in CO-stained tissue. VL was located rostral to VP and appeared lighter than adjacent nuclei (Rt, AV, and VP) in CO-stained tissue. *Bottom*: Location of the recording electrodes in VP (left, purple) and VL (right, cyan) in rats at P12, P16, and P20. CO: Cytochrome oxidase. LD: Lateral dorsal nucleus. MD: Medial dorsal nucleus. Rt: Thalamic reticular nucleus. VP: Ventral posterior nucleus. Pul: Visual pulvinar. LGNd/v: Lateral geniculate nucleus, dorsal and ventral divisions. Pf: Parafascicular nucleus. AD: Anterodorsal nucleus. AV: Anteroventral nucleus. VL: Ventrolateral nucleus.

(B) Mean (\pm SE) number of minutes of active sleep for each animal across each recording session. Data for individual pups are also shown. The amount of time spent in active sleep decreased significantly across age ($F_{2,44} = 18.6$, $p < 0.0001$).

(C) Mean (\pm SE) number of twitches for each animal across each recording session. Data for individual pups are also shown. Twitching decreased significantly across age ($F_{2,44} = 26.8$, $p < 0.0001$).

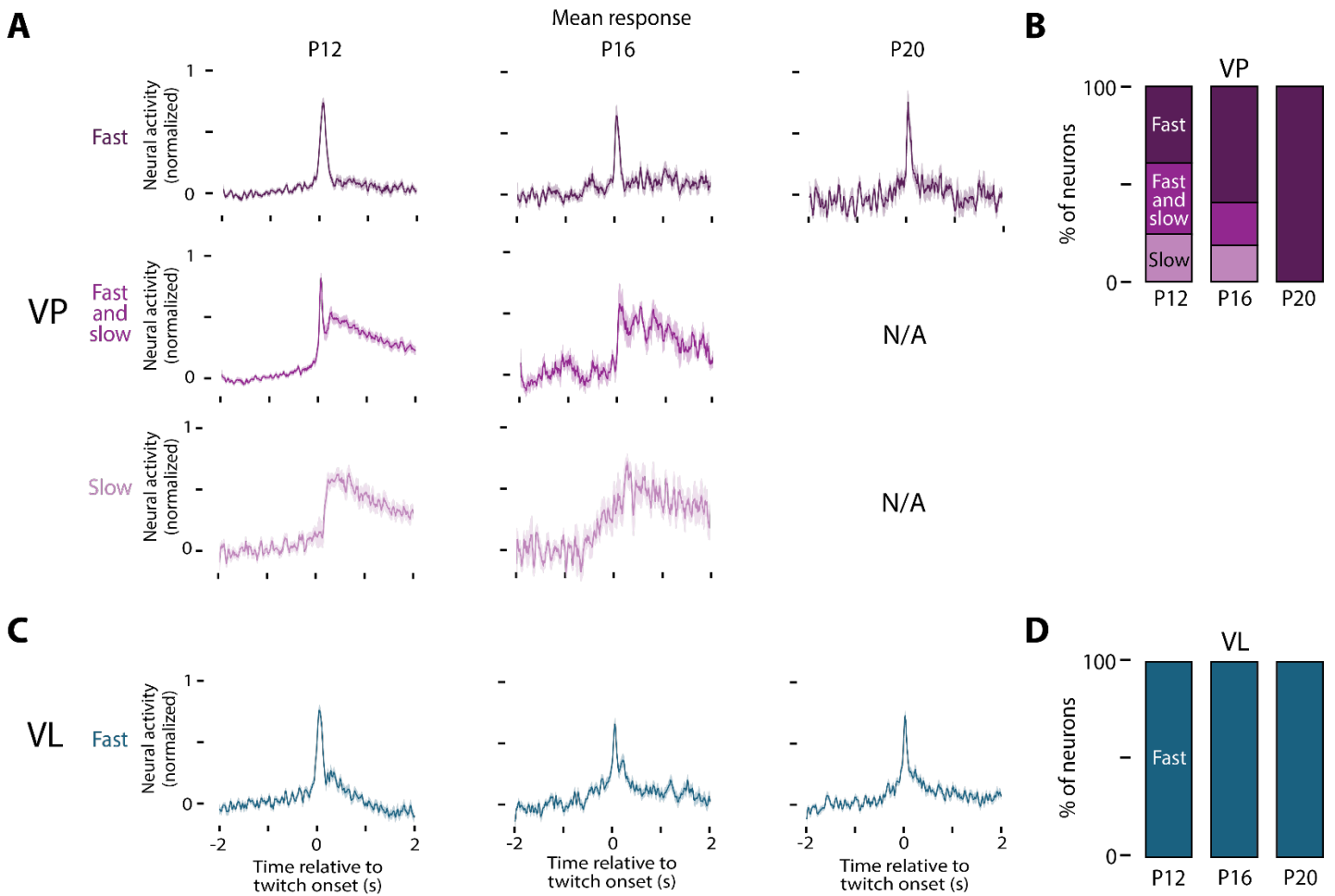


Figure S2. Developmental profiles of fast and slow twitch-responsive thalamic neurons, Related to Figure 2.

(A) Mean (\pm SE) normalized neural response of VP neurons categorized as fast (top, dark purple), fast and slow (middle, purple), and slow (bottom, light purple) at P12, P16, and P20. N/A indicates an absence of neurons in that category.

(B) Stacked plots showing the percentage of VP neurons categorized as fast, fast and slow, and slow at each age.

(C) Same as in (A), but for VL, for which only fast neurons were observed (dark cyan).

(D) Same as in (B), but for VL.

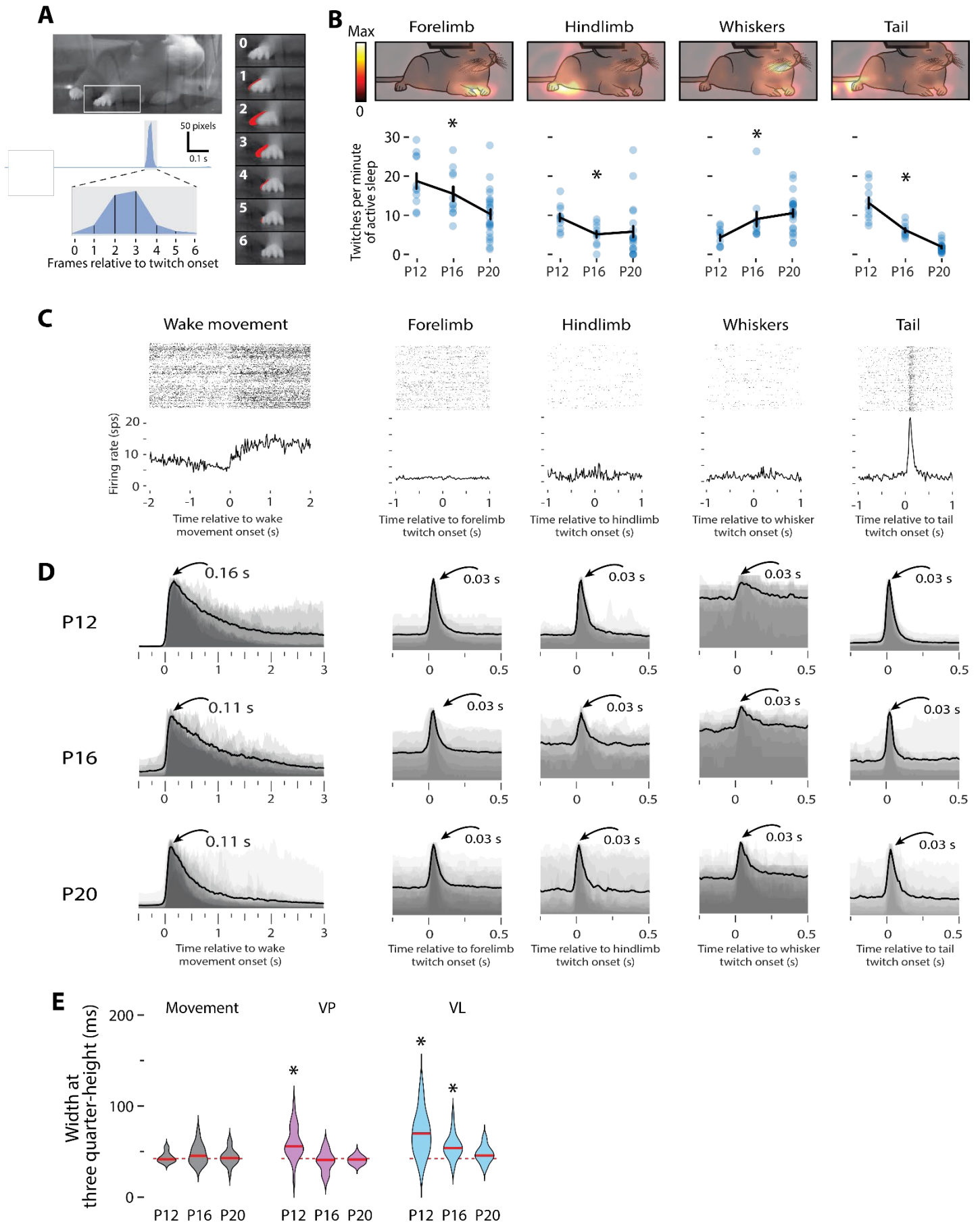


Figure S3. Twitch rates, somatopy, and kinematics across development, Related to Figure 3.

(A) The image at top-left shows a single frame of a P12 rat just before the onset of a twitch of the forelimb. The area within the white rectangle is shown across seven frames in the panels at right. Starting with the top-most frame (frame 0) and moving down frame by frame, the pixels that change from the previous frame are highlighted in red. The forelimb moves the most in frames 2 and 3 and, by frame 6, the movement has stopped. At left-middle, the output of the twitch-movement analysis for a 1-s interval of active sleep. The region around the twitch (gray box) is expanded below to show the time-course over the seven frames.

(B) *Top*: Drawing of a P20 rat overlaid with a heatmap showing the pixels where movement was most likely to occur in the ten frames after the onset of forelimb, hindlimb, whiskers, and tail twitches. *Bottom*: Mean (\pm SE) rate of twitches per min of active sleep for twitches of the forelimb, hindlimb, whiskers, and tail across age. Data for individual sessions are also shown. The rate of twitching decreased significantly across age for the forelimbs ($F_{2,44} = 8.01$, $p < 0.005$), hindlimbs ($F_{2,39} = 7.61$, $p < 0.005$), and tail ($F_{2,44} = 62.9$, $p < 0.0001$), but increased for the whiskers ($F_{2,43} = 5.46$, $p < 0.01$).

(C) Perievent histograms for a representative VP neuron at P12 for movements during wake (single panel at left) and twitches during sleep (four panels at right). This neuron responds weakly to wake movements and negligibly to twitches of the forelimb, hindlimb, and whiskers. In contrast, this neuron responds strongly to twitches of the tail, reflecting somatotopic precision.

(D) Mean displacement produced during wake movements, as well as twitches of the forelimb, hindlimb, whiskers, and tail across age. Each shaded gray region denotes the normalized median displacement produced by that movement for an individual pup. The black line is the mean across all pups for that body part and age. For all twitches across all ages, the mean peak displacement occurs 0.03 s (or three frames) after twitch onset.

(E) Violin plots of the width at three-quarters-height for twitch displacement (gray), twitch-responsive VP neurons (magenta), and twitch-responsive VL neurons (cyan) at each age. The solid red line is the median value at each age and the dotted red line is the grand median across all ages. There was no significant age-related change in movement duration ($H_{(2,144)} = 1.54$, $P = 0.46$), but there was a significant effect of age on response duration in VP ($H_{(2,55)} = 22.15$, $P < 0.001$) and VL ($H_{(2,70)} = 17.6$, $P < 0.001$). VP signed rank: P12: $Z_{29} = 4.03$, $P < 0.001$; P16: $Z_{18} = -1.28$, $P = 0.20$; P20: $Z_{10} = -1.27$, $P = 0.20$. VL signed rank: P12: $Z_{27} = 4.19$, $P < 0.001$; P16: $Z_{24} = 3.65$, $P < 0.001$; P20: $Z_{23} = 1.99$, $P = 0.05$. Asterisks indicate that the median value (red line) is significantly different ($P < 0.0167$) from 0.

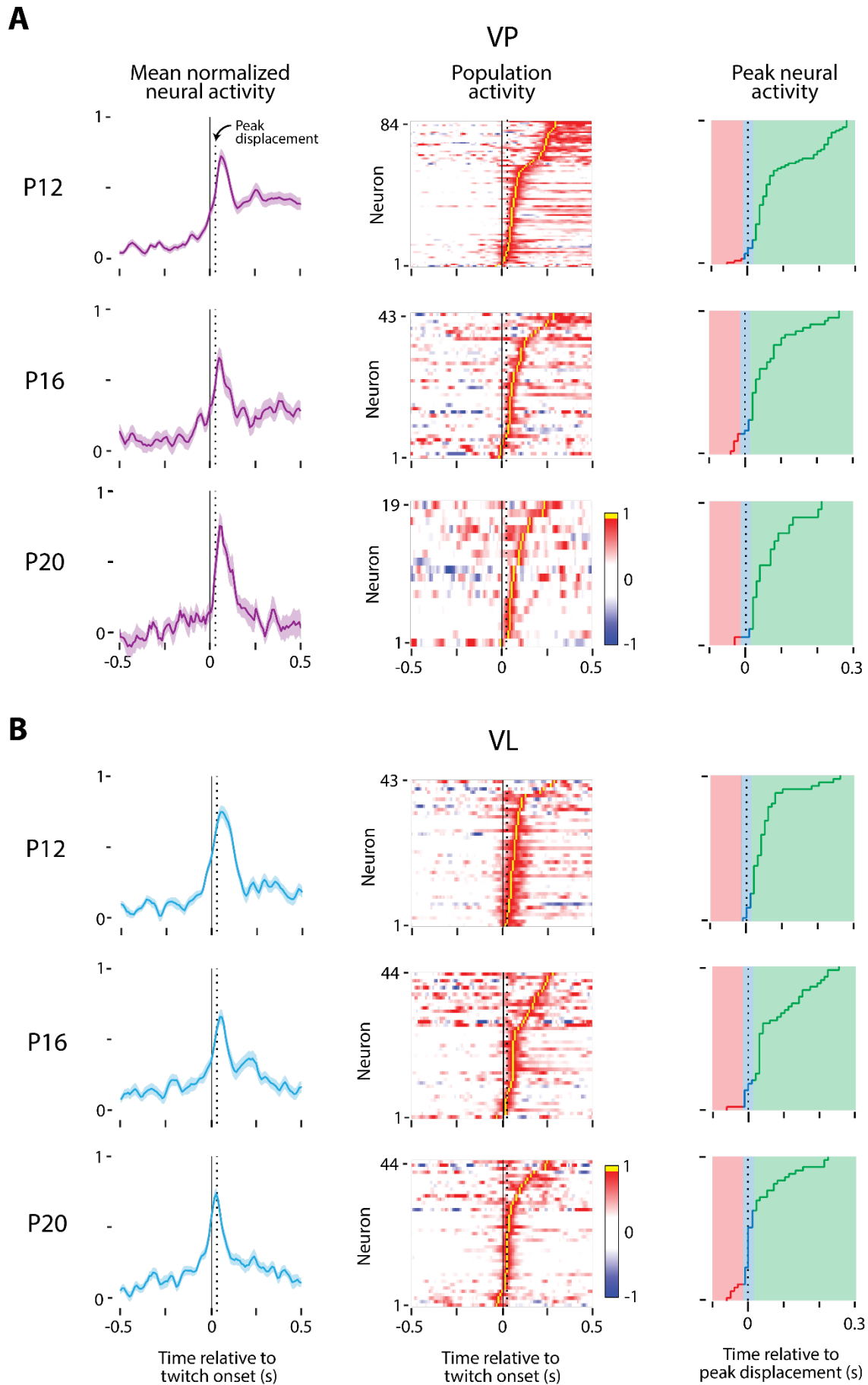


Figure S4. Population-level twitch-related activity in VP and VL, Related to Figure 4.

(A) *Left column*: Mean (\pm SE) normalized neural activity of twitch-responsive VP neurons across age relative to twitch onset (solid vertical line). Peak twitch displacement, occurring at 0.03 s after twitch onset, is also shown (dotted vertical line). *Middle column*: Heatmap of each twitch-responsive VP neuron's activity relative to a twitch, sorted from bottom by increasing peak time. Each neuron's peak activity (yellow) is represented in the right column. *Right column*: The timing of peak activity for each neuron plotted on top of the categories used to classify neural responses in Figure 4A. Red indicates a neuron that fires before peak displacement, whereas green indicates a neuron that fires after peak displacement. Blue are the neurons that fire within 10 ms of peak displacement.

(B) Same as in (A), but for VL.

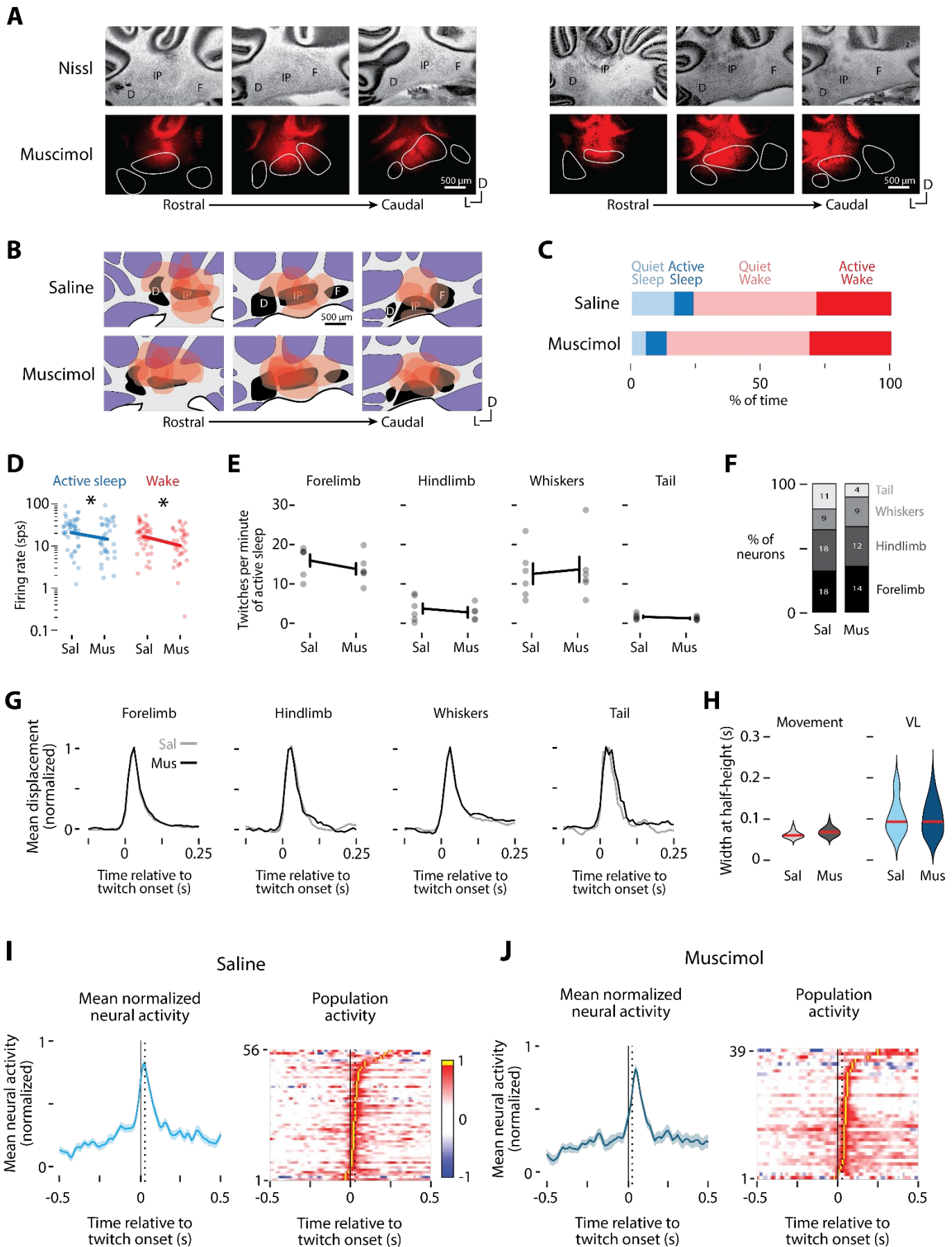


Figure S5. Twitch-related VL activity after injection of muscimol or saline into the DCN at P20, Related to Figure 5.

- (A) Diffusion of fluorescent muscimol (bottom row) in three coronal sections through the deep cerebellar nuclei for two pups. The associated Nissl-stained sections are also shown (top row). D: Dentate. IP: Interposed. F: Fastigial.
- (B) Drawings of the DCN nuclei across three coronal sections to show the lateral and rostrocaudal diffusion of saline (top) or muscimol (bottom). N=6 per group. Abbreviations as in (A).
- (C) Mean percentage of time spent in quiet sleep (light blue), active sleep (dark blue), quiet wake (light red), and active wake (dark red) for pups injected with saline or muscimol.
- (D) Mean log-normalized firing rate of VL neurons during active sleep (blue, left) and wake (red, right) following injection of saline (Sal) or muscimol (Mus). Data for individual neurons are also shown. A 2-way ANOVA reveals a significant effect of injection type ($F_{1,152} = 8.42$, $p < 0.005$) but not behavioral state, with muscimol-injected pups showing less neural activity compared to saline animals (denoted by asterisk).
- (E) Mean (\pm SEM) rate of twitches per min of active sleep for twitches of the forelimb, hindlimb, whiskers, and tail across age. Data for individual pups are also shown. None of the differences are statistically significant.
- (F) Stacked plots showing the percentage of twitch-responsive VL neurons that respond to twitches of different body part in pups injected with saline (left) or muscimol (right). The number of neurons is also indicated.
- (G) Mean normalized movement displacement during twitches of the forelimb, hindlimb, whiskers, and tail in pups injected with saline (gray lines) or muscimol (black lines). The displacement profiles across groups are nearly identical.
- (H) *Left*: Mean (\pm SE) normalized VL activity for saline-injected pups. Peak displacement (0.03 s after twitch onset) is shown as a dotted line. *Right*: Heatmap showing each twitch-responsive neuron's activity relative to a twitch, sorted by peak time. Each neuron's peak activity (yellow) is represented in Figure 5B. The timing of this peak activity relative to peak displacement (dotted line) is used to classify neural responses in Figure 5C.
- (I) Same as in (G), but for muscimol-injected pups.
- (J) *Left*: Violin plots of the width at half-height for twitch movements for pups injected with saline or muscimol. *Right*: Violin plots of the width at half-height for twitch-responsive VL neurons for pups injected with saline or muscimol. The solid red lines denote median values. Neither of the group differences is significant.