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Supplemental information

Tactile processing in mouse cortex depends on action context

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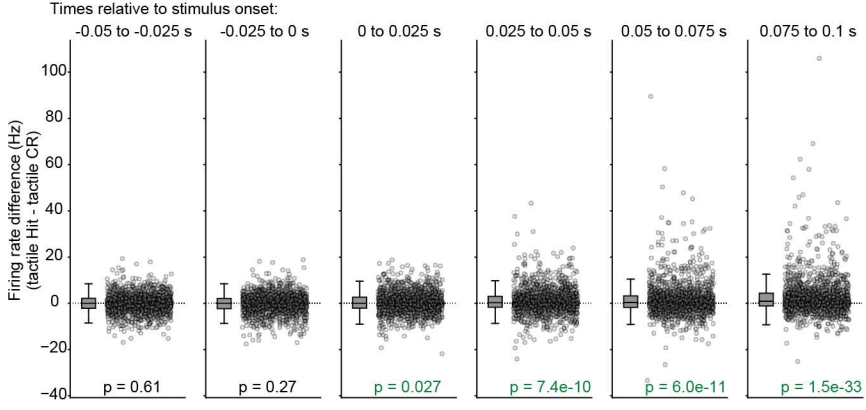

Figure S1. Stimulus relevance enhances early responses to the tactile stimulus. Related to Figure 2.
Difference in mean firing rate between tactile hit trials and tactile correct rejection trials for individual neurons (plot symbols; n = 1539) in 25 ms time bins around the onset of the stimulus. Labels at top of each panel indicate bin times relative to the time of stimulus onset. Mean activity was significantly higher in tactile hit trials beginning with the first time bin after stimulus onset ([0 ms, 25 ms]; p-values from Wilcoxon signed-rank tests shown at bottom of each panel). Boxes indicate median and IQR; whiskers indicate 1.5 x IQR.

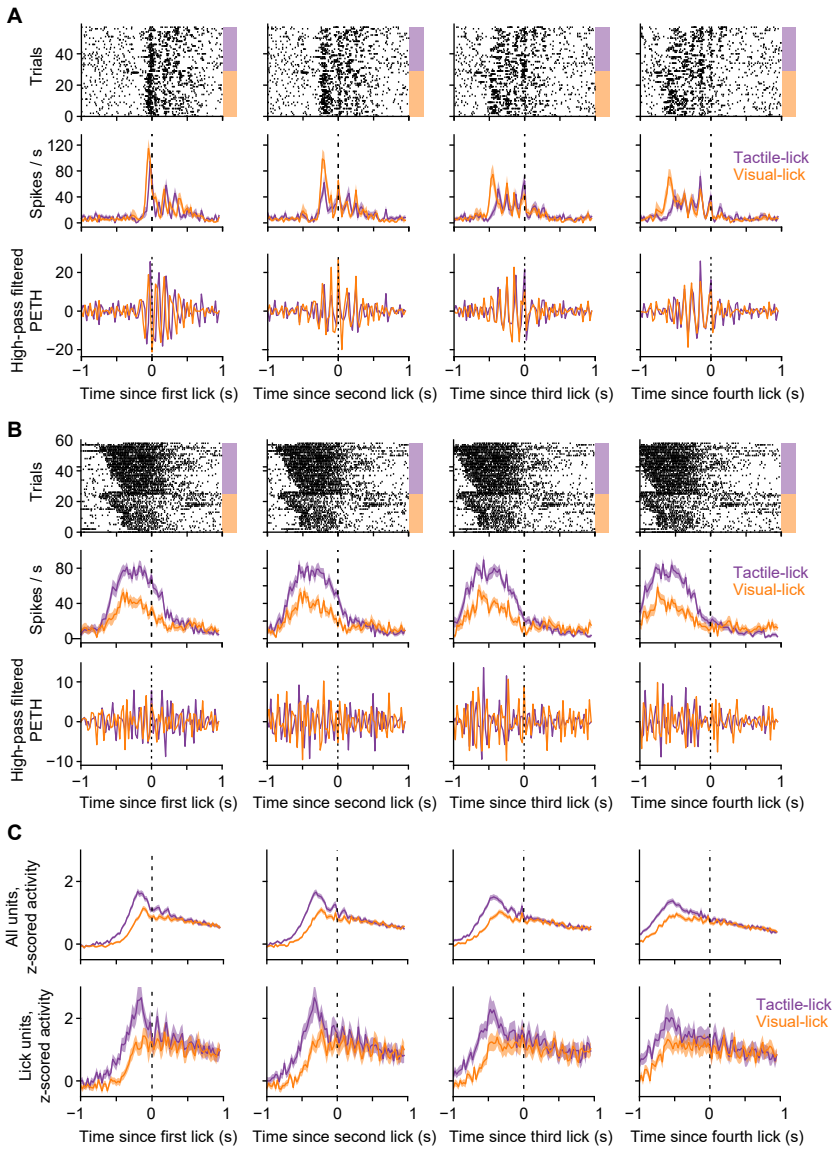

Figure S2. Spiking activity of S1 neurons aligned to individual licks within a bout. Related to Figure 2. (A) Raster plots (top row) and peri-event spike time histograms (PETHs) (middle row; mean ± SEM, 25 ms bins) for an example neuron that showed activity aligned to individual licks. Activity was plotted for touch-lick (purple) or visual-lick trials (orange), and was aligned to the first, second, third, or fourth lick occurring within each trial (columns). PETHs for the same neuron after high-pass filtering (bottom row; cutoff: 8 Hz) to emphasize spike rates at or above typical licking frequencies. (B) Same as (A) but for a neuron that had a significant DP for both touch and visual trials but did not show activity aligned to individual licks. (C) Mean z-scored activity of all neurons (top row; n = 1496) or only those with activity aligned to individual licks (bottom row; n = 139), as determined by a significant autocorrelation at 0.1 s or 0.125 s lag in at least 2 of the 3 high-pass filtered PETHs obtained by alignment to the first, second or third licks.

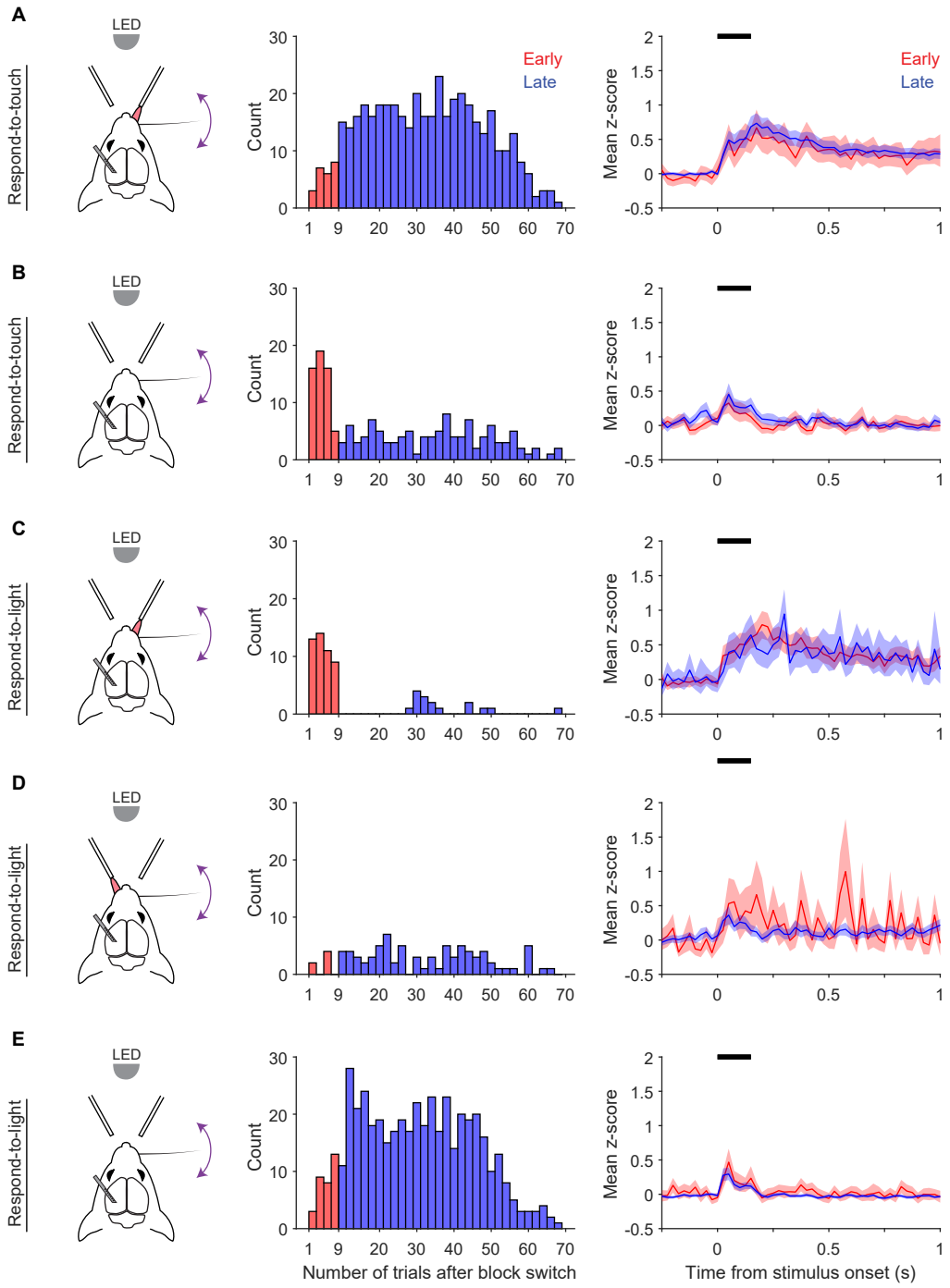

Figure S3. Responses to the tactile stimulus on trials occurring "early" or "late" after block transitions. Related to Figure 2.

(A) Schematic of a tactile hit trial (left column), histogram showing frequency of occurrence of tactile hits at each trial number following the block transition (middle), and the mean z-scored activity across all neurons for early and late trials (right; mean ± 95% CI; 177 neurons from 6 mice acquired using silicon probes). Mice were not immediately cued to the block transition, but could discover the new rule via trial and error in the first few trials after the switch. On the 9th trial, a drop of water at the correct port was given in order to cue any mice that had not already detected the switch. Early (red) and late (blue) trials were defined as those before or after the 9th trial, respectively. (B-E) Same as (A) but for tactile miss (B), two types of tactile false alarm (C and D), and tactile correct rejections (E).

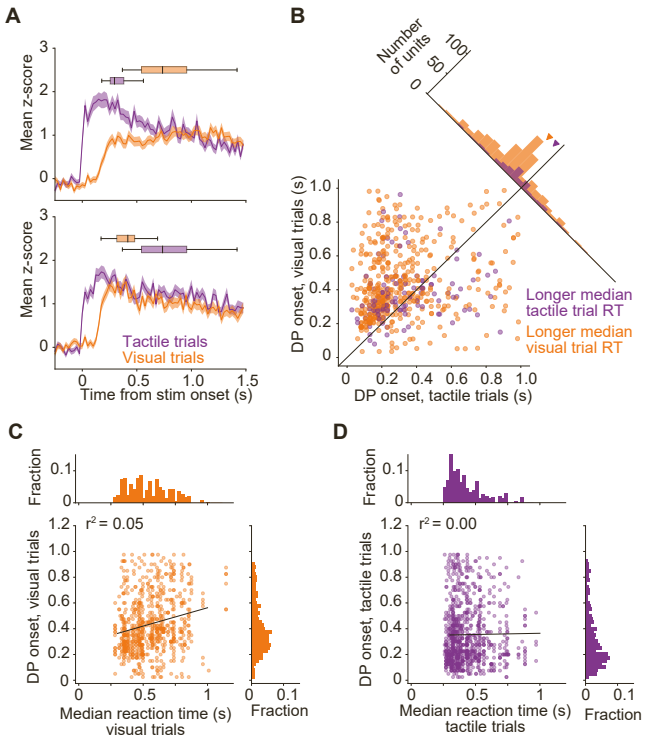

Figure S4. DP onset timing differences between tactile and visual detection are not explained by reaction times. Related to Figure 3.

(A) Recording sessions were grouped into terciles based on each session's median reaction time, separately for tactile and visual reaction times. Top, mean z-scored activity for tactile and visual trials, where the tactile trials came from the first (fastest) tercile group and the visual trials from the third (slowest) tercile group. Reaction time distributions are indicated by horizontal boxplots (median, IQR; whiskers: 1.5 X IQR). Bottom, similar to top panel but comparing tactile trials from third (slowest reaction times) tercile vs visual trials from first (fastest) tercile. (B) Scatter plot and corresponding histogram comparing DP onsets for tactile and visual trials for each neuron grouped by whether neurons were recorded in sessions where the median tactile (purple) or median visual (orange) reaction time was longer. (C) Scatter plot of DP onsets in visual trials as a function of the corresponding median visual trial reaction times for the corresponding session. (D) Same as (C) but for tactile trial DP onsets and tactile trial reaction times.

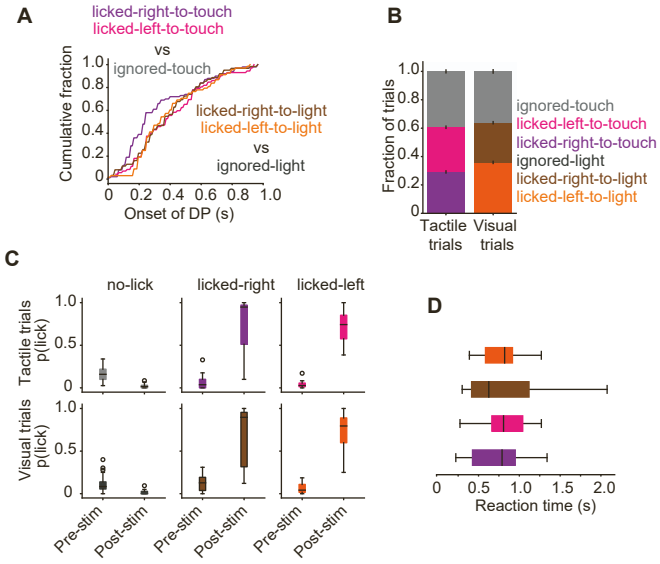

Figure S5. Performance of mice trained in a cross-modal task version with additional block types to switch lick direction. Related to Figure 4.

(A) Cumulative histogram of DP onset times for different trial types from neurons recorded during the modified cross-modal selection task. (B) Fractions of different trial outcomes for tactile and visual trials (error bars: ± SEM; n = 28 sessions). (C) Distributions across sessions of the probability of each possible lick outcome, separately for post-stimulus and pre-stimulus periods. (D) Distributions of reaction times for the different trial types. (C-D) Boxes indicate median and IQR; whiskers indicate 1.5 x IQR; fliers indicate values greater than 1.5 x IQR.

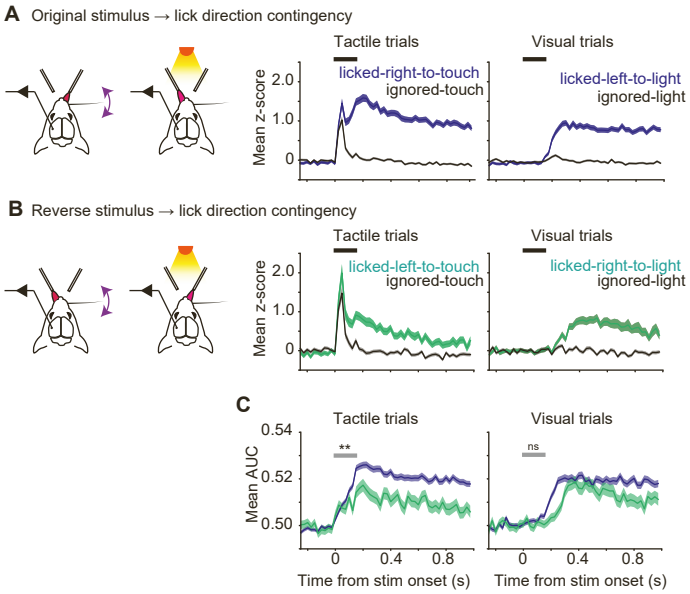

Figure S6. Greater motor-related activity in mice trained to lick right in response to touch compared with mice trained to lick left in response to touch. Related to Figure 4.

(A) Task design and mean z-scored activity (± SEM) by trial outcome for neurons recorded in mice (n = 11) trained on the cross-modal selection task with the original stimulus → lick direction contingency (respond-right-to-touch; respond-left-to-light). (B) Same as (A) but for mice (n = 4) trained on the cross-modal selection task with reverse stimulus → lick direction contingency (respond-left-to-touch; respond-right-to-light). (C) Left, mean AUC (± SEM) for an ideal observer discriminating licked-right-to-touch vs ignored-touch trials (purple) or discriminating licked-left-to-touch vs ignored-touch trials (green). Right, similar to left but for an ideal observer discriminating licked-left-to-light vs ignored-light (purple) or discriminating licked-right-to-light vs ignored-light (green). Blue and green curves are significantly different in the first 150 ms window after stimulus onset for tactile trials ($p = 0.014$, two-sided t-test, n =1539 for lick-right-to-touch, n = 549 for lick-left-to-touch), but not for visual trials ($p = 0.545$, two-sided t-test, n =1539 for lick-left-to-light, n = 549 for lick-right-to-light).

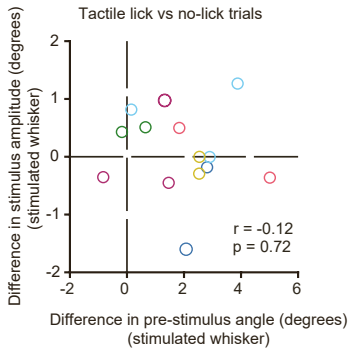

Figure S7. High-speed video analysis of pre-stimulus whisker angle and measured stimulus amplitude. Related to Figure 5.

Mean difference between tactile lick and tactile no-lick trials in measured amplitude of the whisker stimulus (STAR Methods), plotted against the difference in pre-stimulus whisker angle. Plot symbols show sessions, color-coded by individual mouse. Pearson correlation coefficient and corresponding p-value are indicated.