**Supplementary Figure 1. Recording locations.** Left, Cresyl-violet-stained, 75-μm-thick histology sections showing the dorsal hippocampus and representative tetrode locations for three rats for left and right hemispheres. For each rat, five to eight tetrodes (out of 20) per hemisphere were selected based on broad spatial distribution within the exit cannula of the drive (and thus, presumed spatial distribution within the brain) and lesions were produced via current passage through those tetrodes. All lesions were observed to be in dorsal area CA1 after histology. Large arrowheads mark lesion locations. Small double-arrowheads mark tetrode track paths for both lesioned and non-lesioned tetrodes. Rat 4 histology sections were not produced. Right, Locations for all lesioned tetrodes for Rat 1 (black), Rat 2 (red), and Rat 3 (green). Posterior distance from bregma (mm) marked on each section. Image on right modified from [Paxinos, G., and Watson, C. *The rat brain in stereotaxic coordinates.* Academic press, (2007)].
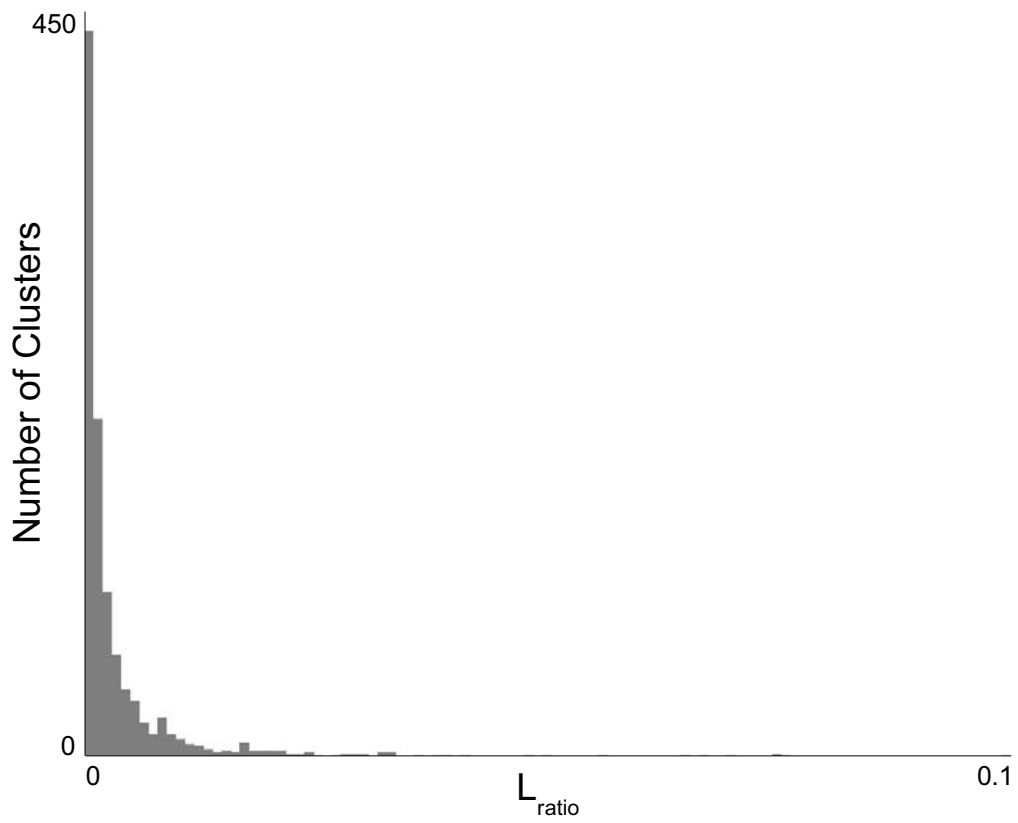
Supplementary Figure 2. Unit cluster quality measurement. Histogram (bin size = 0.001) of L_{ratios} for all manually clustered, putative excitatory units.
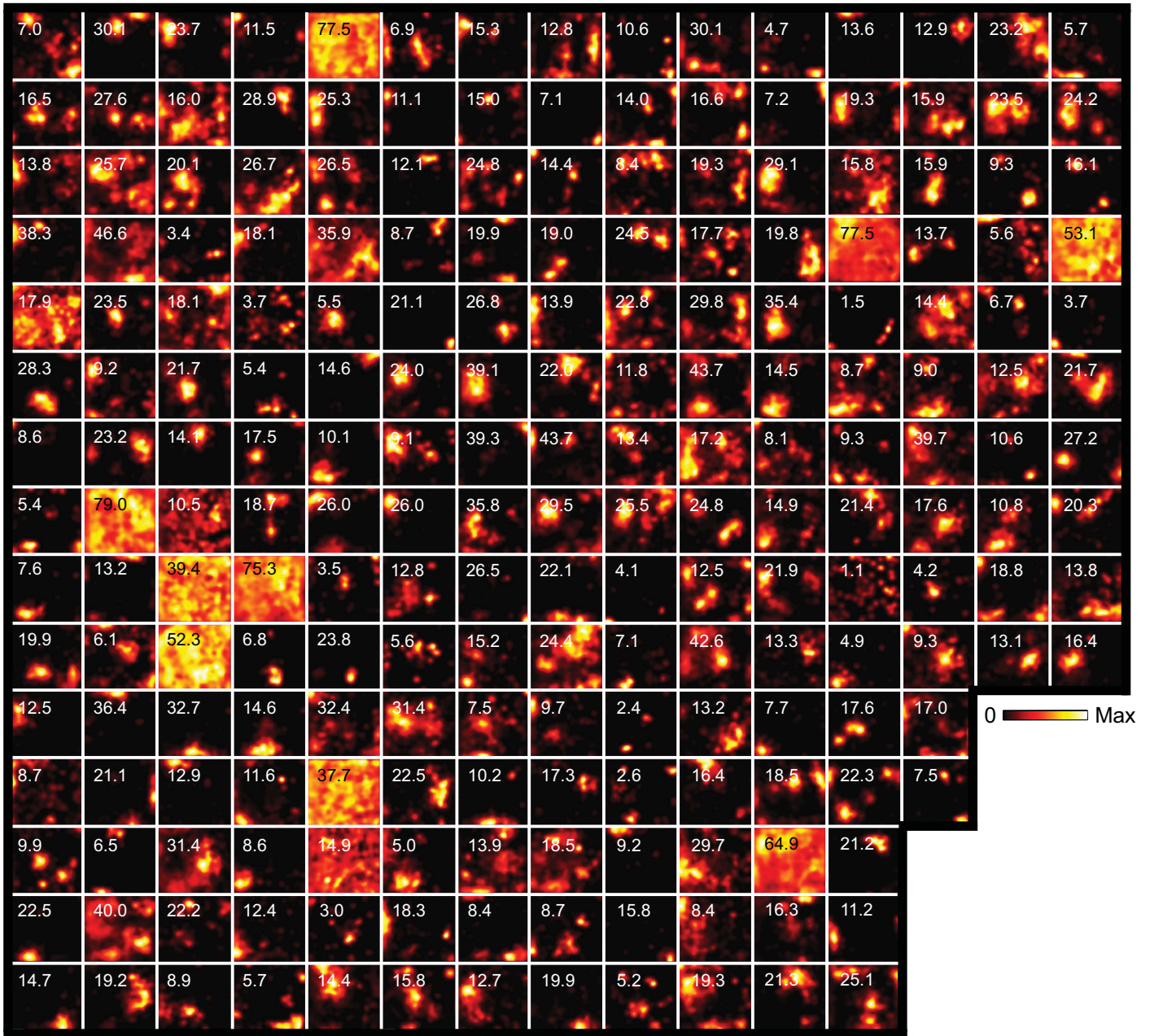
Supplementary Figure 3. Place fields for a representative session. Position tuning curves for 212 simultaneously recorded units for rat 1 on experimental day 1. Each white box represents the firing map for a different unit within the 2 m x 2 m arena. The colormap displays the smoothed firing rate for each unit ranging from 0 (black) to the maximum (white) listed in the upper-left corner of each box (in Hz). Units with their maximum firing rate listed in black font were classified as putative inhibitory neurons based on mean firing rate and spike width.
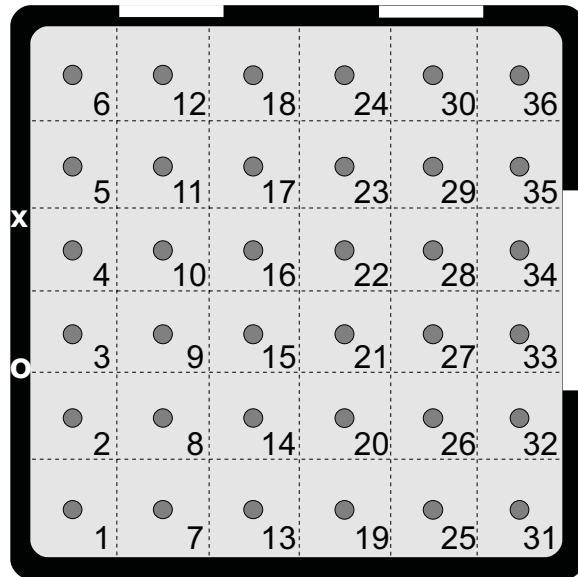
**Supplementary Figure 4. Arena segmentation.** Dashed lines indicate the boundaries used for quantification of each of the 36 wells within the 2 m x 2 m arena. Well number indicated in each region. This well number is used to identify wells in **Figure 3** and **Supplemental Figures 5**, **9-10**, **12-16**, and **19**. Well #15 is the *HOME* well for Day 1. Well #29 is the *HOME* well for Day 2.
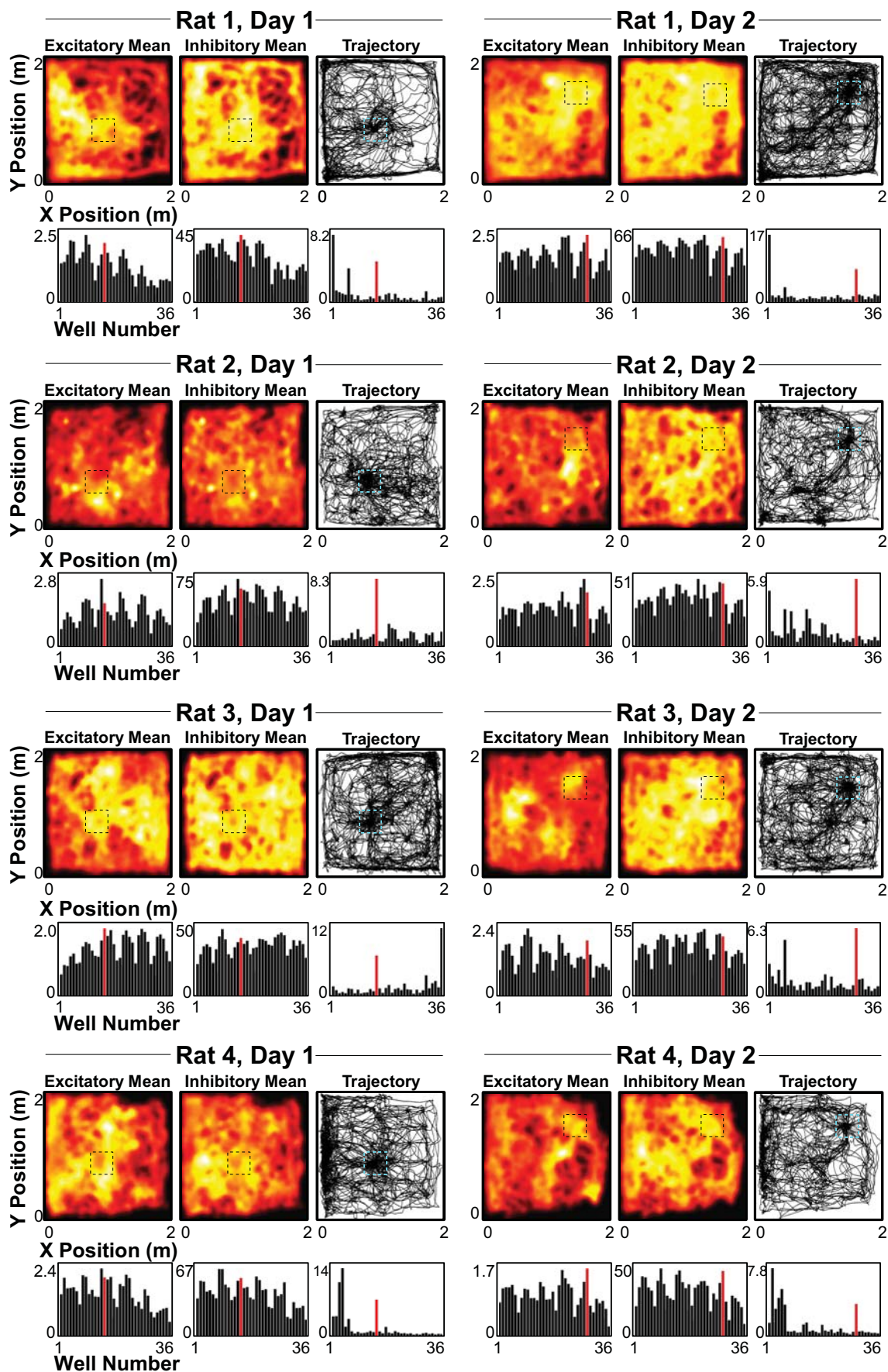
Supplementary Figure 5. Place field sums and behavioral trajectories. For all sessions, mean of all putative excitatory unit place fields (left), mean of all putative inhibitory unit place fields (center), and trajectory of rat throughout entire session (right). *HOME* location depicted with dashed box. Quantification of the average firing rate (in Hz) or total occupancy time (in minutes) per well region is shown beneath each graph. *HOME* well location is designated in red on bar graph.
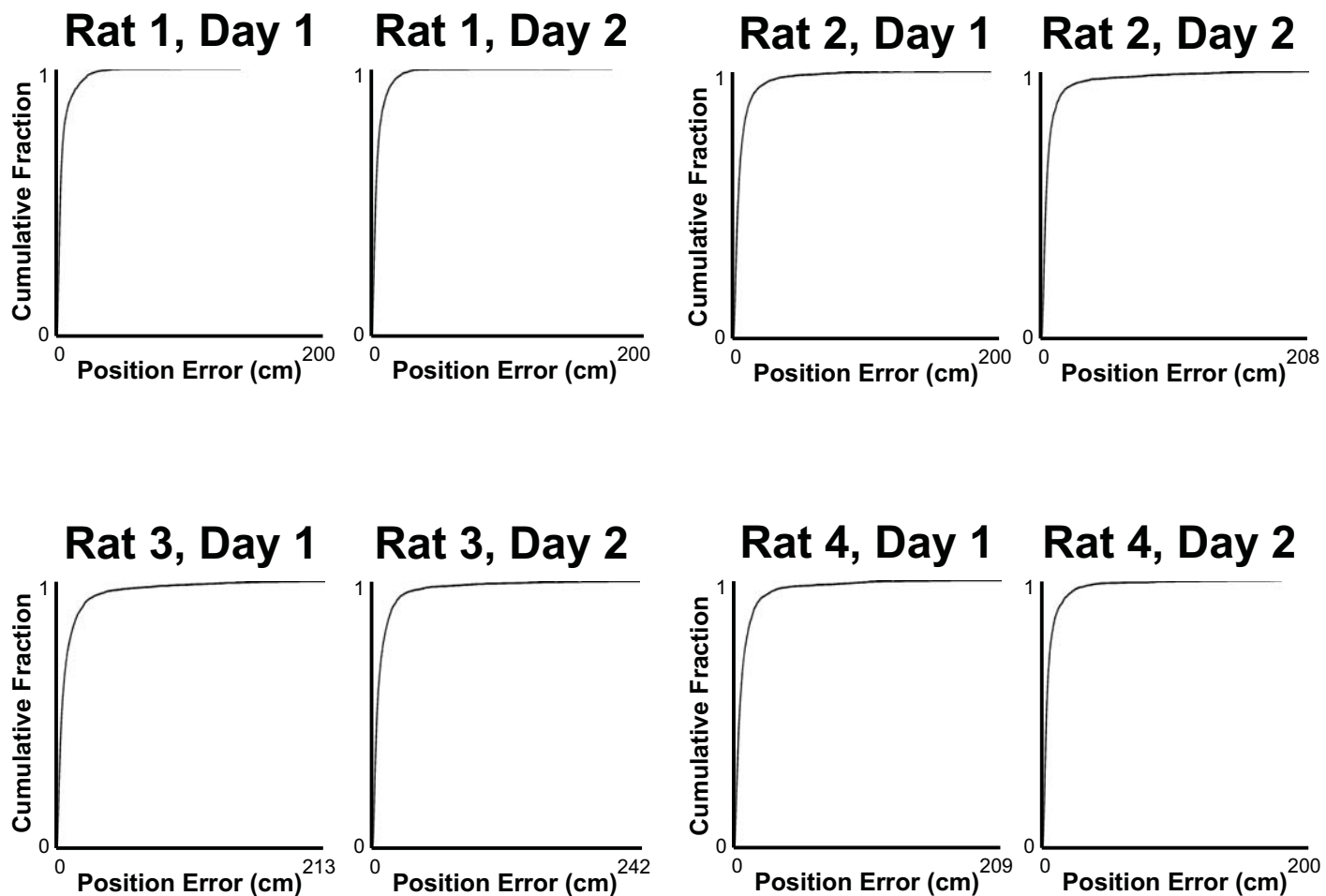
Supplementary Figure 6. Decoding accuracy in the open field. For all sessions, the cumulative fraction of time bins throughout the entire experiment (250 ms, non-overlapping time bins) and the position error (the distance between the rat's mean position throughout the time bin and the position bin of peak posterior probability from the decoding of the spikes that occurred during that time bin). Only times in which the rat's velocity was greater than 5 cm/s were used for this analysis.
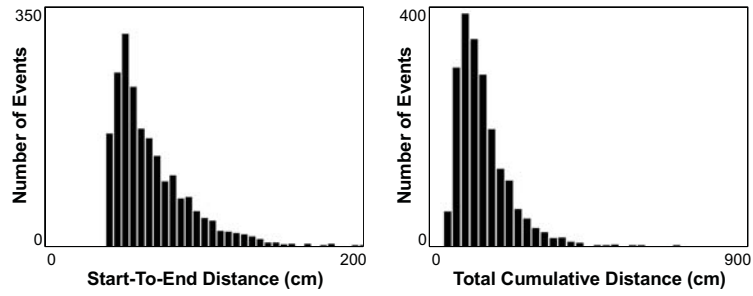
Supplementary Figure 7. Trajectory event lengths. Histogram of the start-to-end (5 cm bins, left) or total cumulative (25 cm bins, right) distance for all trajectory events across all sessions.
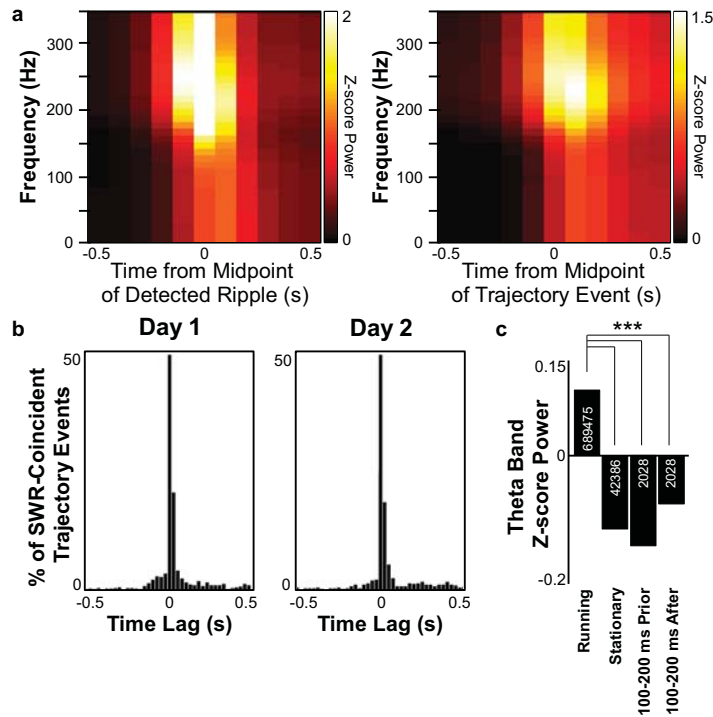
Supplementary Figure 8. Trajectory events are associated with sharp-wave/ripples.
a, Average SWR-event-triggered (left)- or trajectory-event-triggered (right) spectrograms
for all sessions. **b,** Cross-correlation of trajectory event times with hippocampal SWR
times for all sessions for Day 1 and Day 2. **c,** For all sessions, the average theta band (4-
12 Hz) power for all times in which the rat was running (velocity > 5 cm/s) or stationary
(velocity < 2 cm/s) and for 100-200 ms immediately before and 100-200 ms immediately
after each trajectory event. *P*-values (Kruskal-Wallis ANOVA, Scheffe's post-hoc multiple-
comparison): *** < 1 x 10^{-6}.
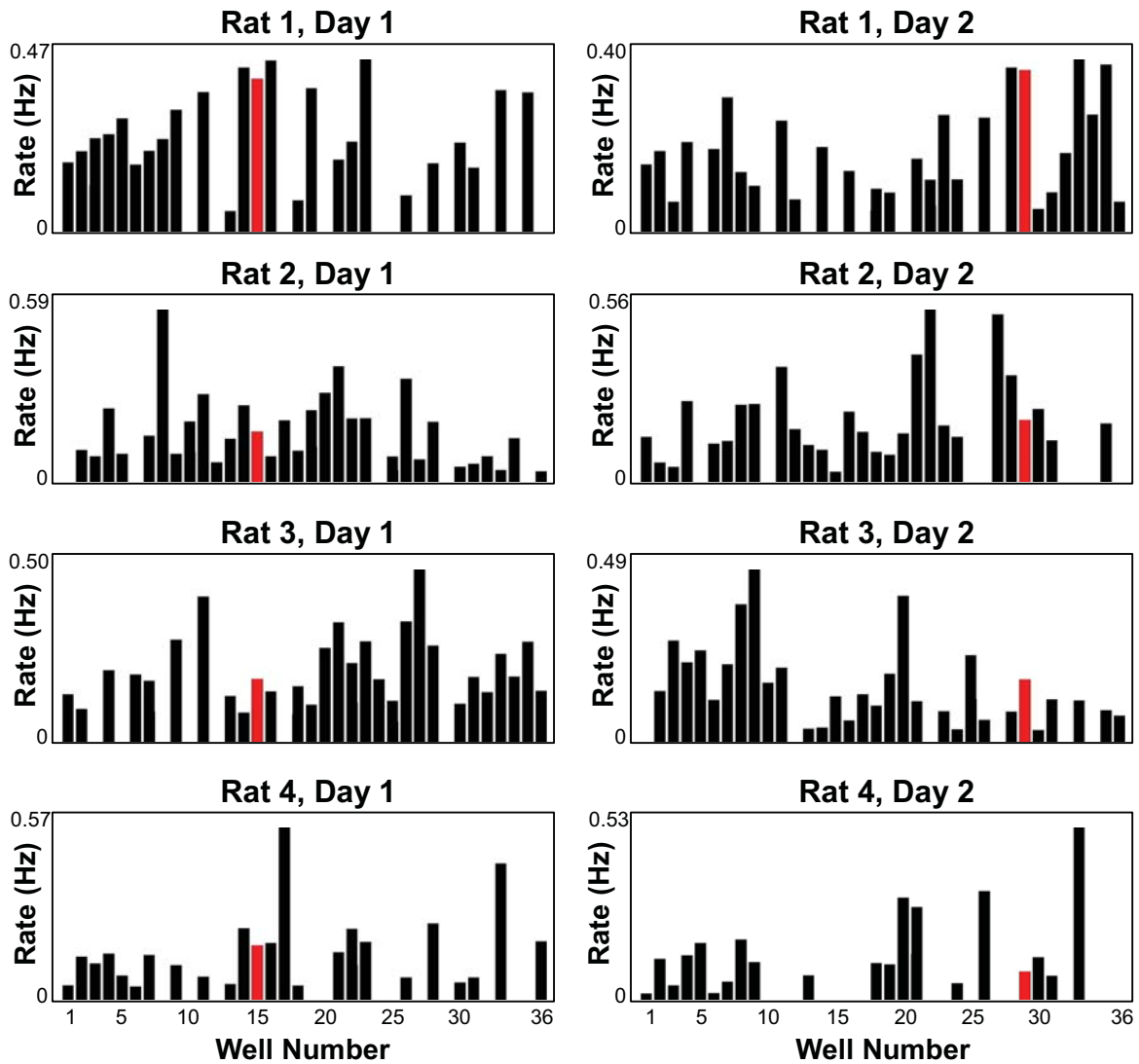
Supplementary Figure 9. Location of trajectory event initiation. For each session, for each well, trajectory event rate was calculated as the number of trajectory events which occured while the rat was physically at the well divided by the total amount of time spent immobile at the well. *HOME* location is designated in red.
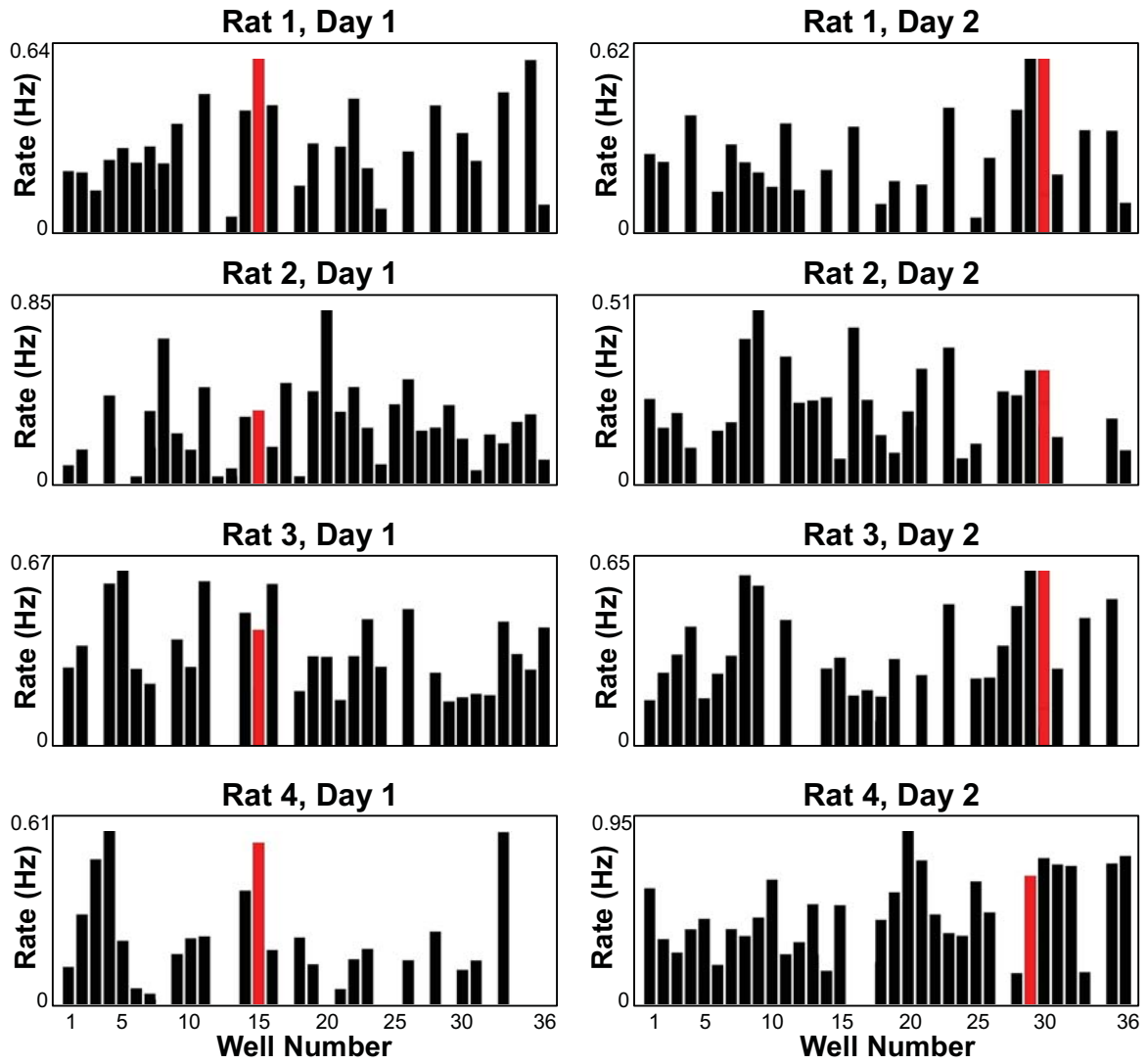
Supplementary Figure 10. Location of sharp-wave/ripple initiation. As **Supplemental Figure 9**, for sharp-wave/ripple event rate.
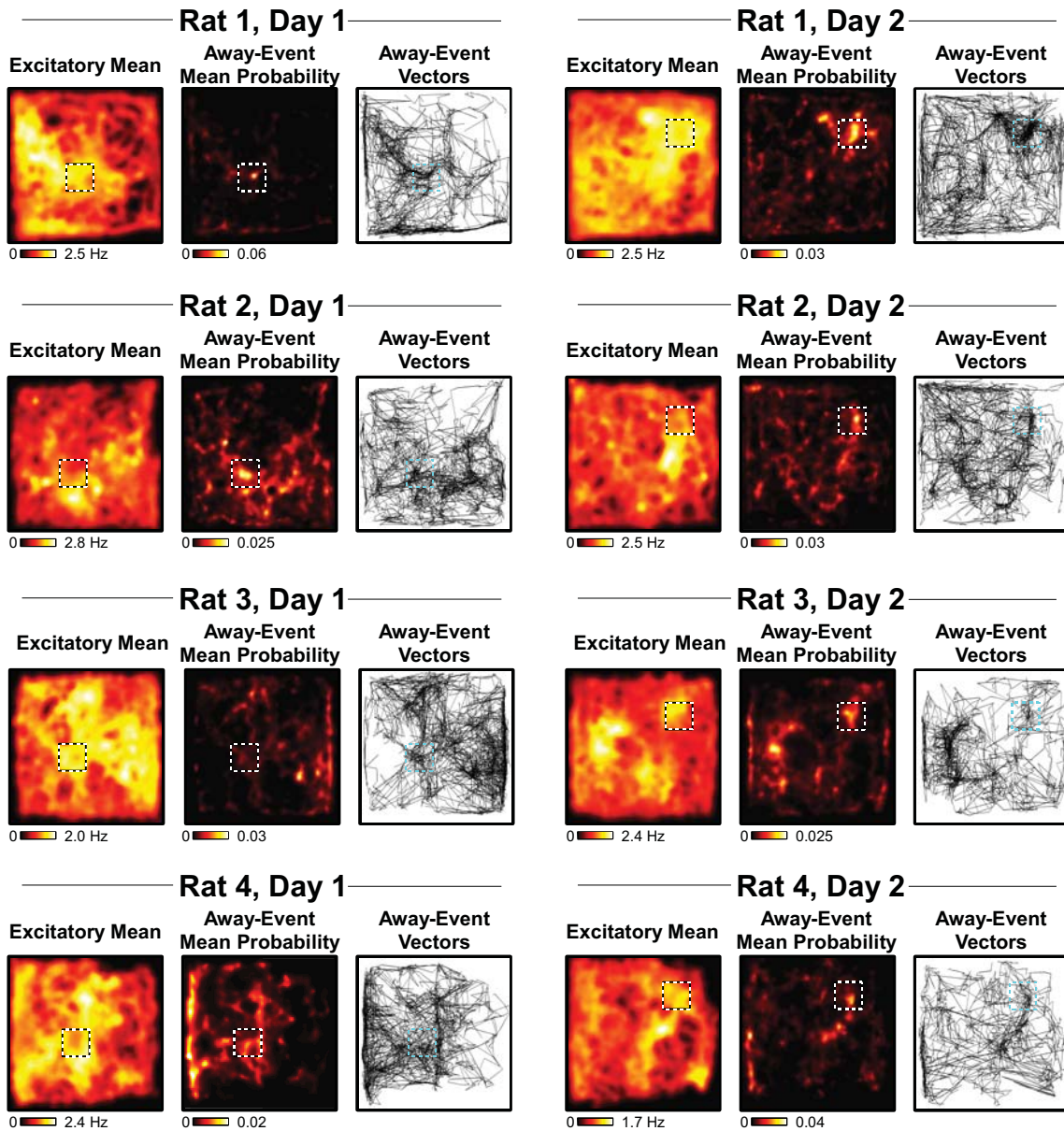
Supplementary Figure 11. Away-events for all sessions. For all sessions, mean of all putative excitatory unit place fields (left), the average away-event posterior probabilities (center), and the vectorized away-event trajectories (right) are plotted for each session. *HOME* location depicted with dashed box. Note the correlation between place field distribution and event probabilities and trajectories, which is quantified in **Supplementary Figure 15**.
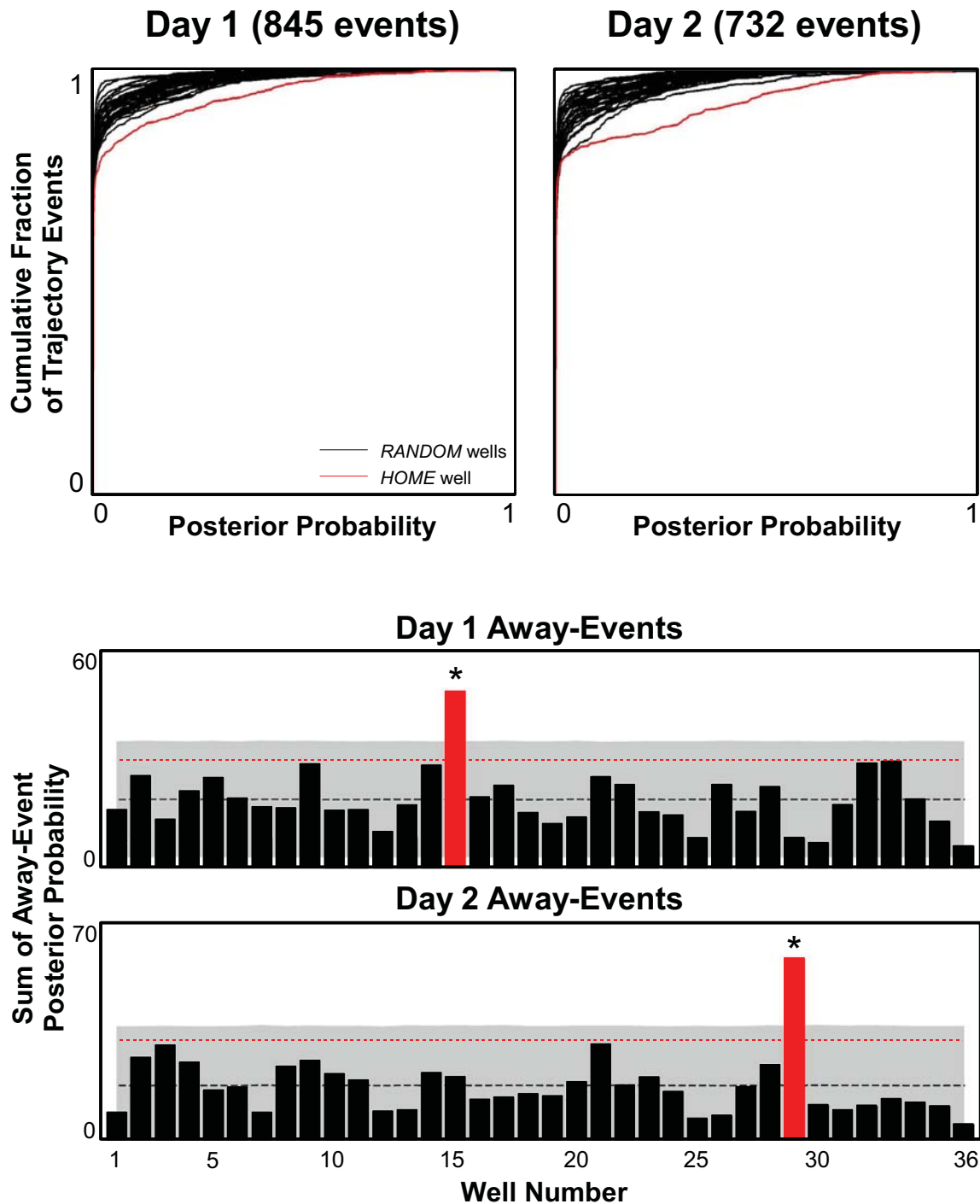
Supplementary Figure 12. *HOME* representation in away-events. Top, for each well, for Day 1 and Day 2, cumulative distribution of the trajectory event posterior probability in that well location for all away-events. *HOME* well distribution (red) is significantly smaller (*i.e.*, *HOME* well posterior probabilities are larger) than all other wells. *P*-values (two-sample Kolmogorov-Smirnov test) D1<2.3x10^{-2}; D2<1.1x10^{-2}. Bottom, per-well quantification (sum across all events) of the posterior probability for all away-events across all rats for D1 and D2. For each event, well identity was independently shuffled 1,000 times to generate a Monte-Carlo *P*-value for each well's sum. *HOME* well (red bar) for both days is the only well with a Monte-Carlo *P*-value < 0.05 (D1 0.028; D2 0.028). Dashed black line indicates mean value for the shuffles for each well and grey shaded area indicates mean ± 2 standard deviations. Dashed red line indicates Monte-Carlo *P*-value boundary of 0.05.
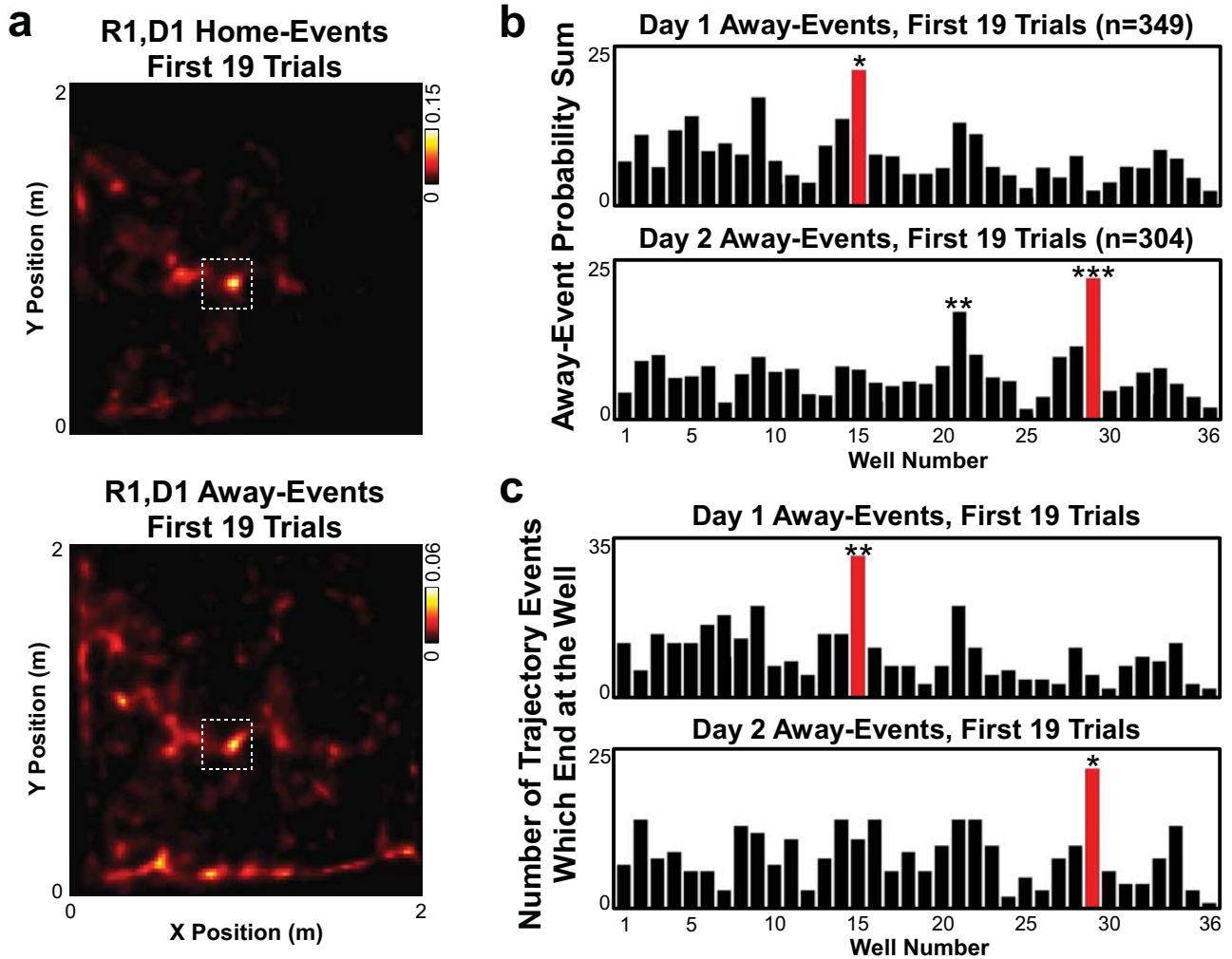
Supplementary Figure 13. Analysis of first nineteen trials per session. a, Average posterior probability sum of all home-events (top) or away-events (bottom) for the first 19 trials for Rat 1, Day 1. **b,** Per-well quantification (sum across all events) of the posterior probability for all away events across all rats for D1 and D2 for only the first 19 trials of each session. *HOME* well (red) is a statistical outlier for both days. *P*-values (Grubbs' test for outliers): D1 1.7×10^{-2}, D2 **9.3×10^{-3}, ***6.0×10^{-4}. **c,** Quantification of the number of away-events for the first 19 trials in which the peak posterior probability of the final frame of the trajectory event was at a given well. *HOME* well (red) is a statistical outlier for both days. *P*-values (Grubbs' test for outliers): D1 4.8×10^{-3}; D2 4.8×10^{-2}.
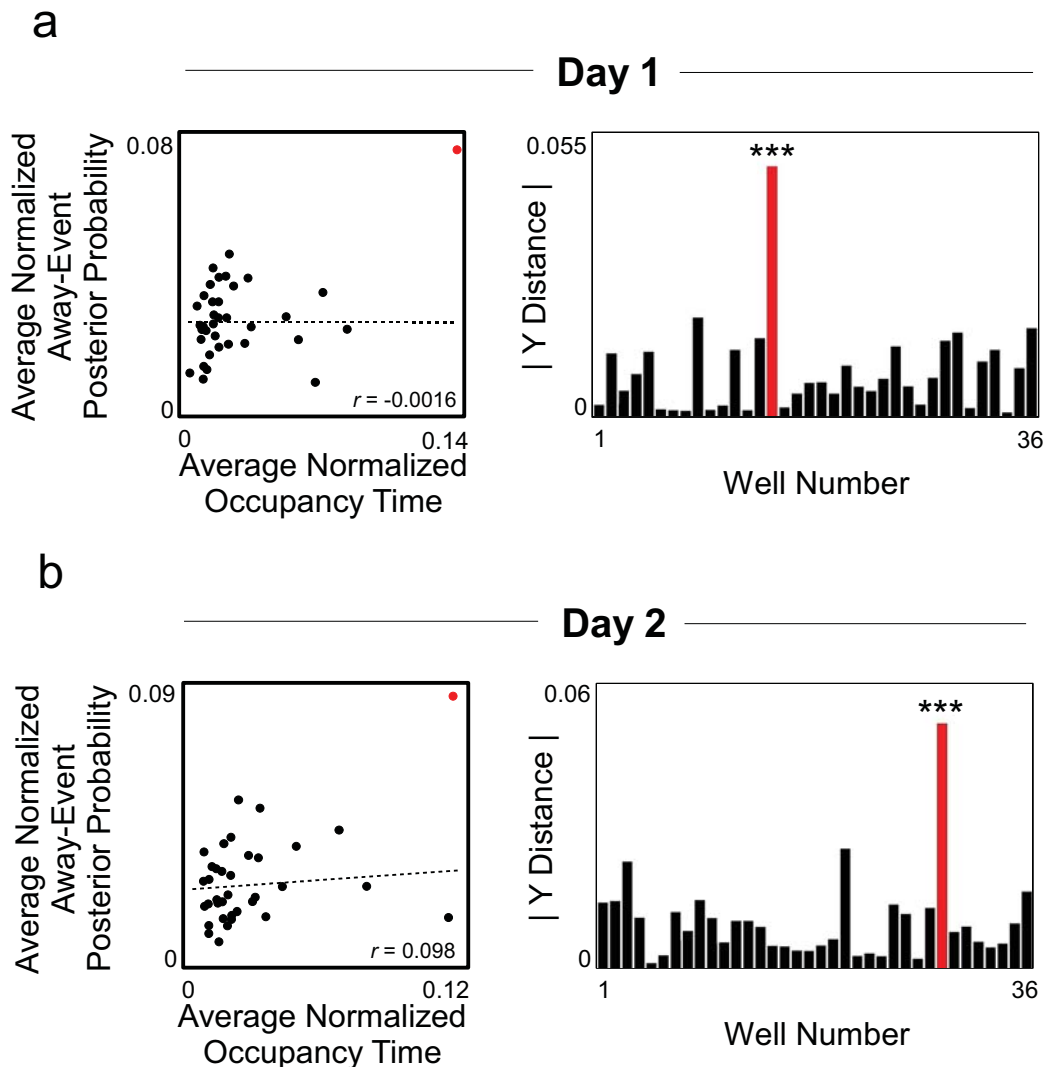
Supplementary Figure 14. Correlation between occupancy time and trajectory event representation. a, Left, For each rat, for Day 1, normalized away-event posterior probability and normalized occupancy time was calculated per well. Displayed is the average of this normalized away-event representation and occupancy time across all rats. *HOME* well shown in red. To test the hypothesis that the representation of the *HOME* well can be explained by occupancy time, we determined the relationship for all non-goal wells between the representation in away-events and occupancy time and asked if the *HOME* well shares that relationship. Black dashed line indicates best-fit line (least squares) for all non-*HOME* wells. Pearson's r = -0.0016 (P = 0.99). Data from each session has been normalized before averaging so that if occupancy time completely accounted for the representation in away-events, the *HOME* well would lie along the best-fit line. Right, Absolute Y-axis distance of each well from the best-fit line. *HOME* well shown in red. *HOME* well is the only statistical outlier (Grubb's test for outliers, *HOME P* = 4.72x10^{-7}). **b**, As **a**, for Day 2. Pearson's r = 0.098 (P = 0.58). *HOME* well is the only statistical outlier (Grubb's test for outliers, *HOME P* = 3.47x10^{-7}).
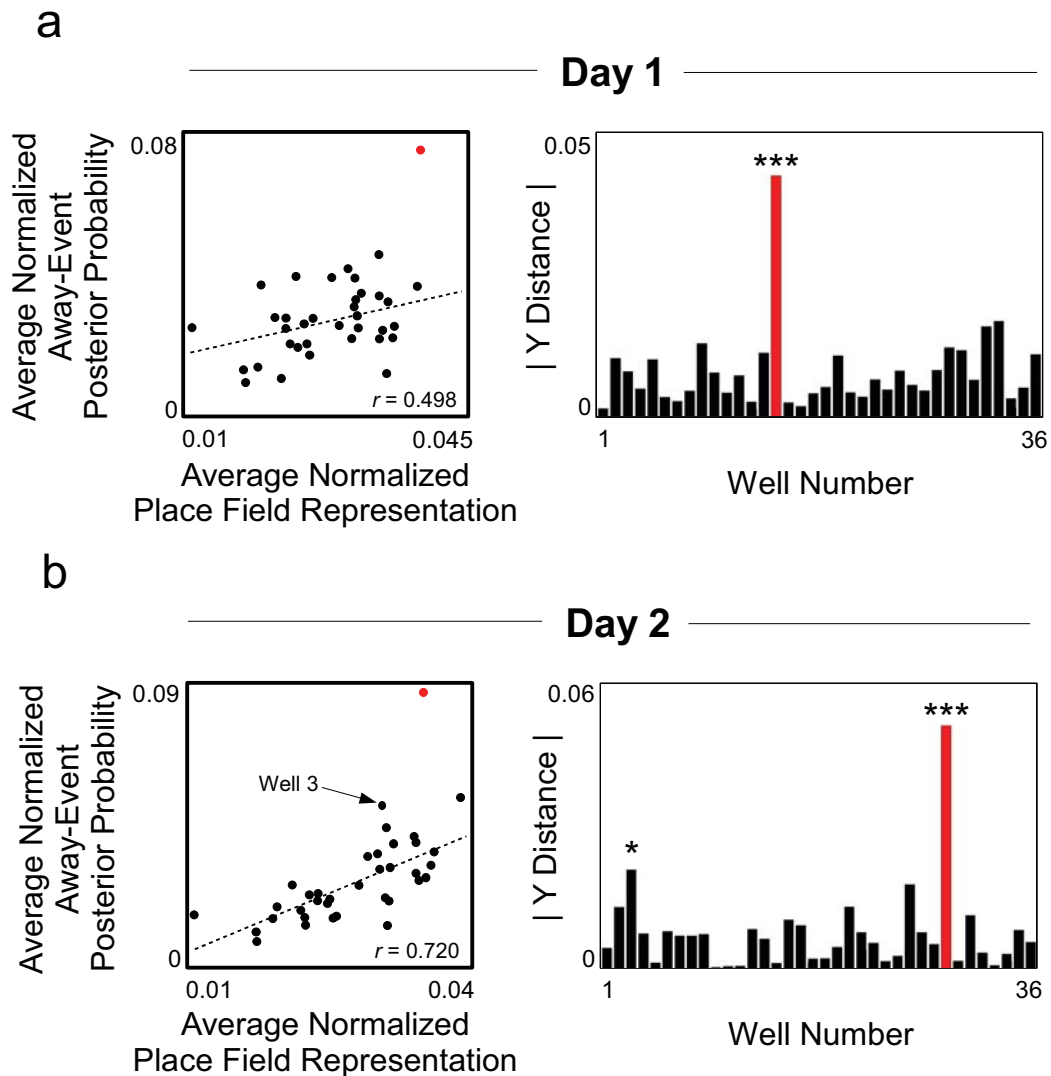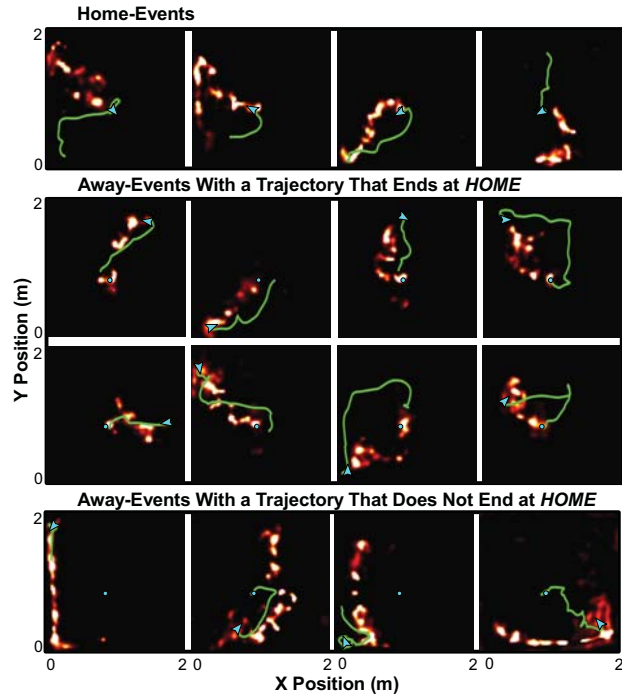
Supplementary Figure 15. Correlation between place field distribution and trajectory event representation. a, Left, For each rat, for Day 1, normalized away-event posterior probability and normalized place field representation was calculated per well. Displayed is the average of this normalized away-event and place field representation across all rats. *HOME* well shown in red. To test the hypothesis that the representation of the *HOME* well can be explained by place field distribution, we determined the relationship for all non-goal wells between the representation in away-events and the representation by place fields and asked if the *HOME* well shares that relationship. Black dashed line indicates best-fit line (linear, least squares) for all non-*HOME* wells. Pearson's $r = 0.498$ ($P = 2.30 \times 10^{-3}$). Data from each session has been normalized before averaging so that if place field representation completely accounted for the representation in away-events, the *HOME* well would lie along the best-fit line. Right, absolute Y distance of each well from the best-fit line. *HOME* well shown in red. *HOME* well is the only statistical outlier (Grubb's test for outliers, $P = 1.04 \times 10^{-8}$). **b**, As **a**, for Day 2. Pearson's $r = 0.720$ ($P = 1.11 \times 10^{-6}$). The *HOME* well is a statistical outlier (Grubb's test for outliers, *HOME* $P = 4.37 \times 10^{-9}$; Well 3 $P = 0.0406$.
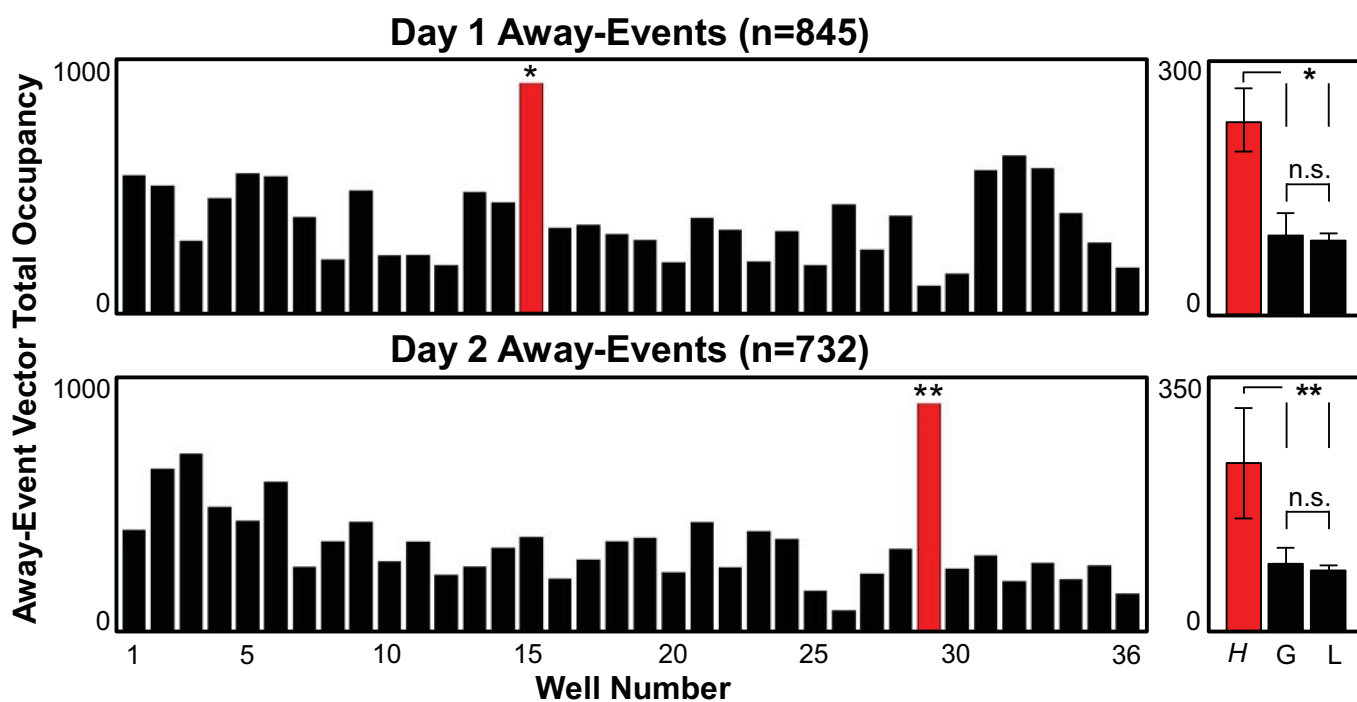
Supplementary Figure 16. Analysis of vectorized trajectory events. a, Left, Each away-event was vectorized by identifying the peak posterior probability position bin for every time frame. Vector occupancy is the number of frames of the trajectory event which have a peak posterior probability in that location. *HOME* well (red bar) is a statistical outlier. *P*-values (Grubb's test for outliers): D1 *P*=0.015; D2 *P*=0.0065. Right, as **Figure 3e right**, quantification of the mean vector occupancy for the *HOME* well (*H*, 8 wells; 4 on D1, 4 on D2), for all wells with a greater physical occupancy than the *HOME* well (*i.e.*, the rat spends more time in the well than it does at the *HOME* well, G; 8 wells, 4 on D1, 4 on D2), and for all wells with a lesser physical occupancy than the *HOME* well (L; 272 wells). *P*-values (ANOVA, Tukey-Kramer post-hoc multiple comparison): D1 *H* vs. G 4.4×10^{-2}; *H* vs L 1.4×10^{-3}; G vs L 0.99; D2 *H* vs G 5.6×10^{-3}; *H* vs L 9.9×10^{-6}; G vs L 0.94.

Future Path Denoted

Home-Events

Away-Events With a Trajectory That Ends at *HOME*

Away-Events With a Trajectory That Does Not End at *HOME*

X Position (m)

Y Position (m)

Past Path Denoted

Home-Events

Away-Events With a Trajectory That Ends at *HOME*

Away-Events With a Trajectory That Does Not End at *HOME*

X Position (m)

Y Position (m)
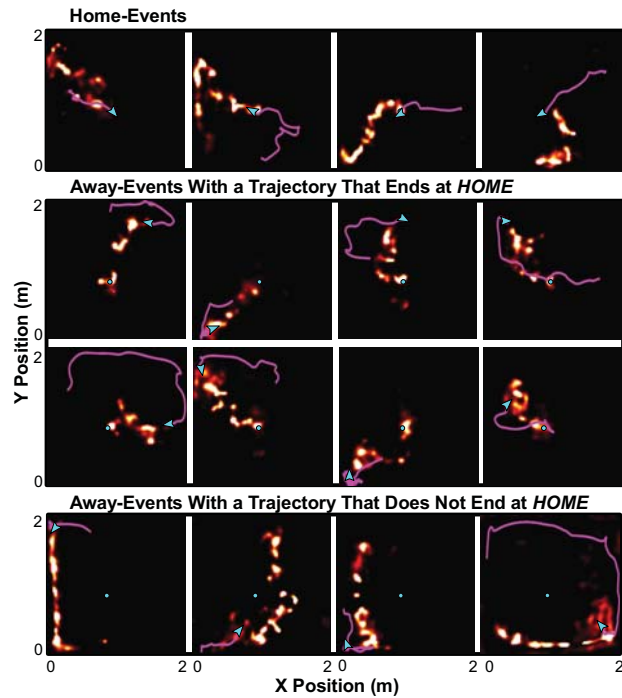
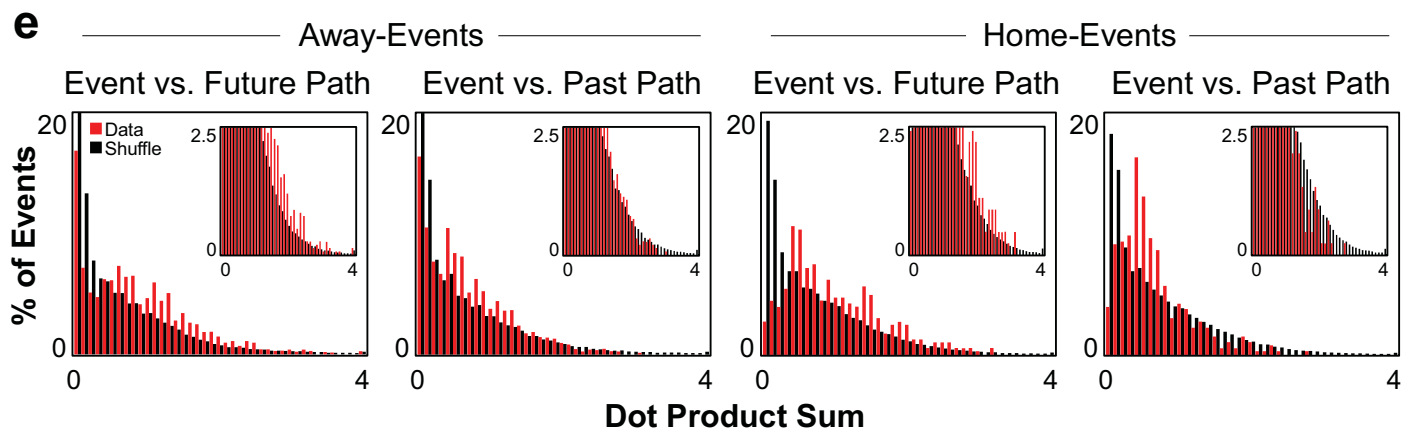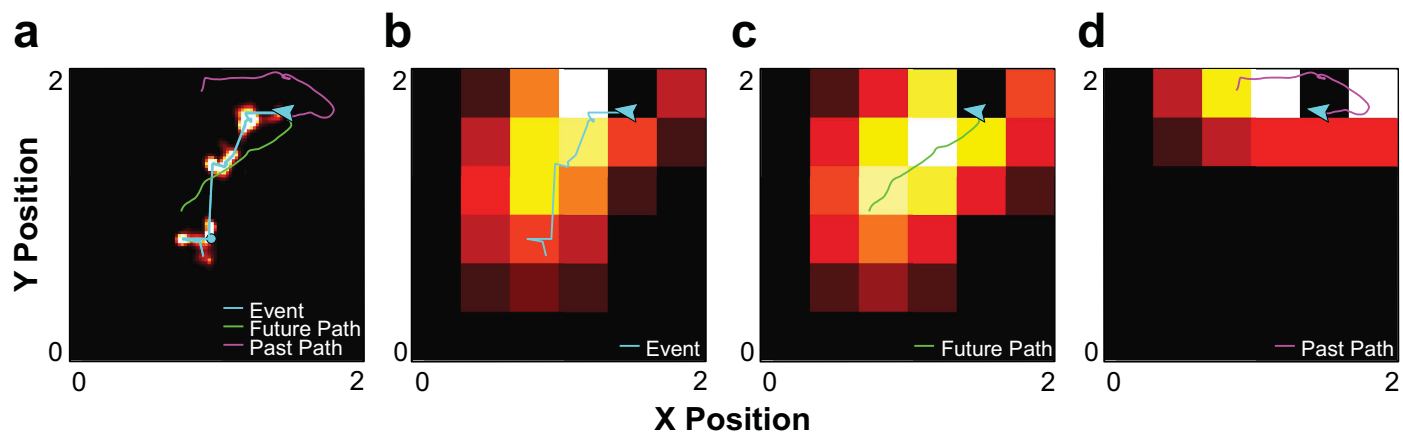**Supplementary Figure 17. Representative events and the rat's future/past path.**
Representative events from **Figure 2c** demonstrating the rat's future (top, in green) or past (bottom, in magenta) path (greater of 10 s or 50 cm traveled). *HOME* well location marked with cyan circle. Rat location and head direction at the time of each even shown by cyan arrowhead.
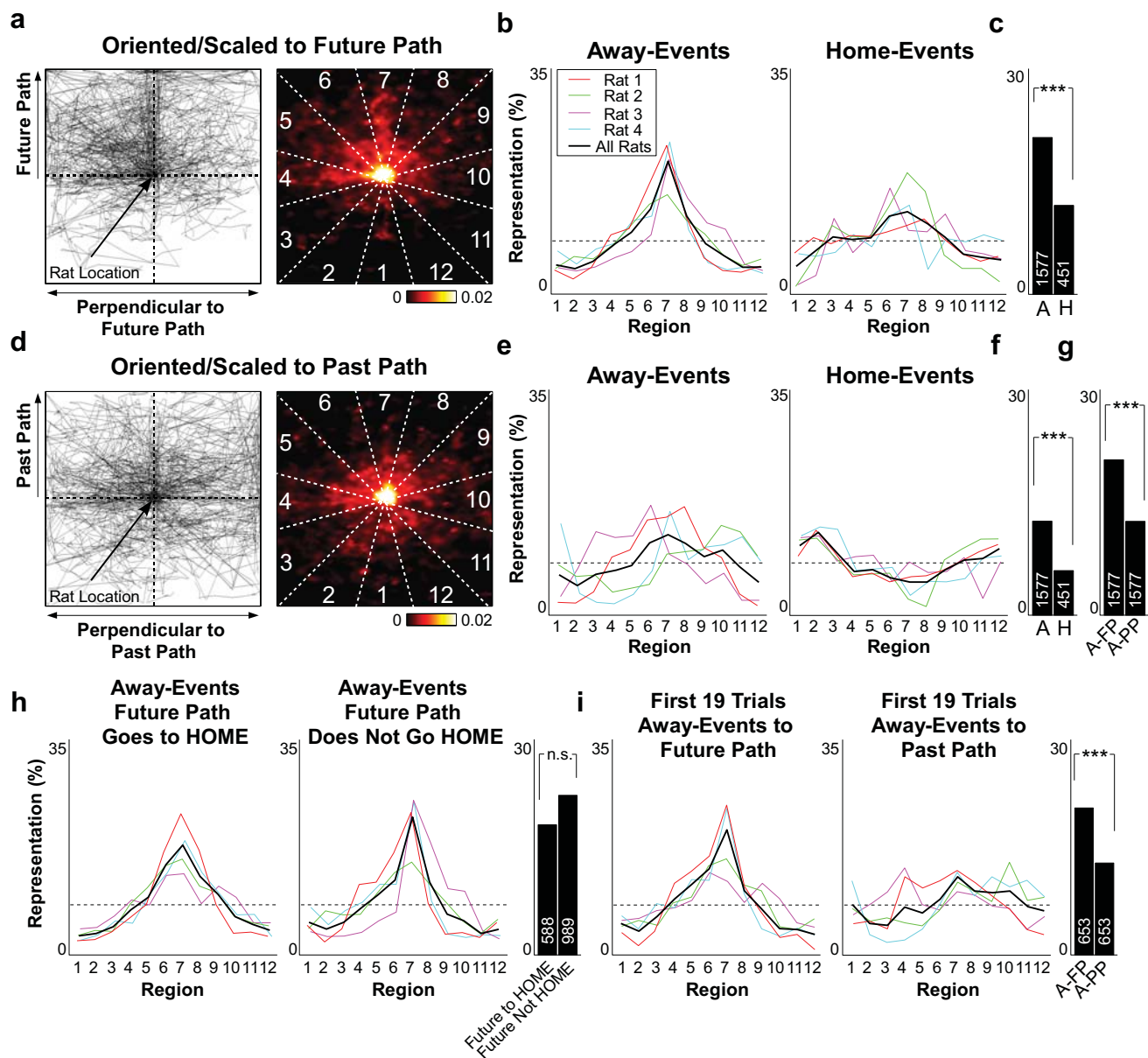
Supplementary Figure 18. Rotational analysis of the spatial correlation of trajectory events with the rat's future and past path. a, Vectorized trajectories (left) and average posterior probability sum (right) of all trajectory events for R1,D1, centered by the rat's physical location at the time of each event and rotated and scaled according to the end point of the rat's immediate future path (assessed at 10 s later, or at 50 cm distance if greater) following each event. Regions used for quantification displayed on right. The rat's future path ends in region 7 for all events. **b**, For all sessions, quantification of the mean representation of each region for all away- and home-events centered and rotated as in **a**. Dashed line represents chance (equal representation in all regions). **c**, Quantification (mean) for segment 7 for all away (A)- or home (H)-events. **d-f**, As **a-c**, with events centered by the rat's physical location and rotated and scaled according to the starting point of the rat's recent past path (assessed at 10 s prior, or at 50 cm distance if greater). **g**, Quantification of future path (A-FP) vs. past path (A-PP) correlation for away-events. **h**, As **b-c**, with away events subdivided into those in which the rat's actual future path crosses or ends at the *HOME* location and those in which the rat's future path does not. **i**, As **b-c**, with all away-events from only the first 19 trials of each session. *P*-values (Wilcoxon rank sum test): **c**) 1.3×10^{-6}; **f**) 3.0×10^{-7}; **g**) 8.6×10^{-20}; **h**) 0.49; **i**) 9.6×10^{-8}.

Supplementary Figure 19. Dot product analysis of the spatial correlation of trajectory events with the rat's future and past path. a, As in **Figure 2e**, a representative event from Rat 1, Day 1, demonstrating the trajectory event vector (the peak posterior probability for each time frame of the decoded event, cyan), the rat's future path (green), and the rat's past path (magenta). **b-d**, For the trajectory event vector (**b**), the future path vector (**c**), and the past path vector (**d**), the wells that were crossed by the vector were determined, resulting in a binary histogram, which was smoothed with a gaussian filter extending one well in all directions with a standard deviation of one well. To eliminate initiation bias, the well occupied by the rat was set to zero. For every trajectory event, the dot product of these smoothed maps was quantified and a Monte-Carlo P-value was calculated by comparing the dot product of the future/past path maps and the maps of 2,000 randomly-selected trajectory events that were spatially relocated to align the rat's location at the time of each shuffled event to the rat's location at the time of the event being tested. **e**, For all sessions combined, histogram (as percent of events) of the dot product for each away-event or home-event as it relates to the rat's future or past path. The inset is a zoomed version of the data. A value of 0 indicates no overlap between the trajectory event map and the future/past path map; higher values inidicate greater overlap. **f**, Table of the number of away-events and home-events across all sessions that match the rat's future or past path (Monte-Carlo P-value<0.05) and the binomial cumulative distribution probability of observing that number of matching events with an expected probability of 0.05.
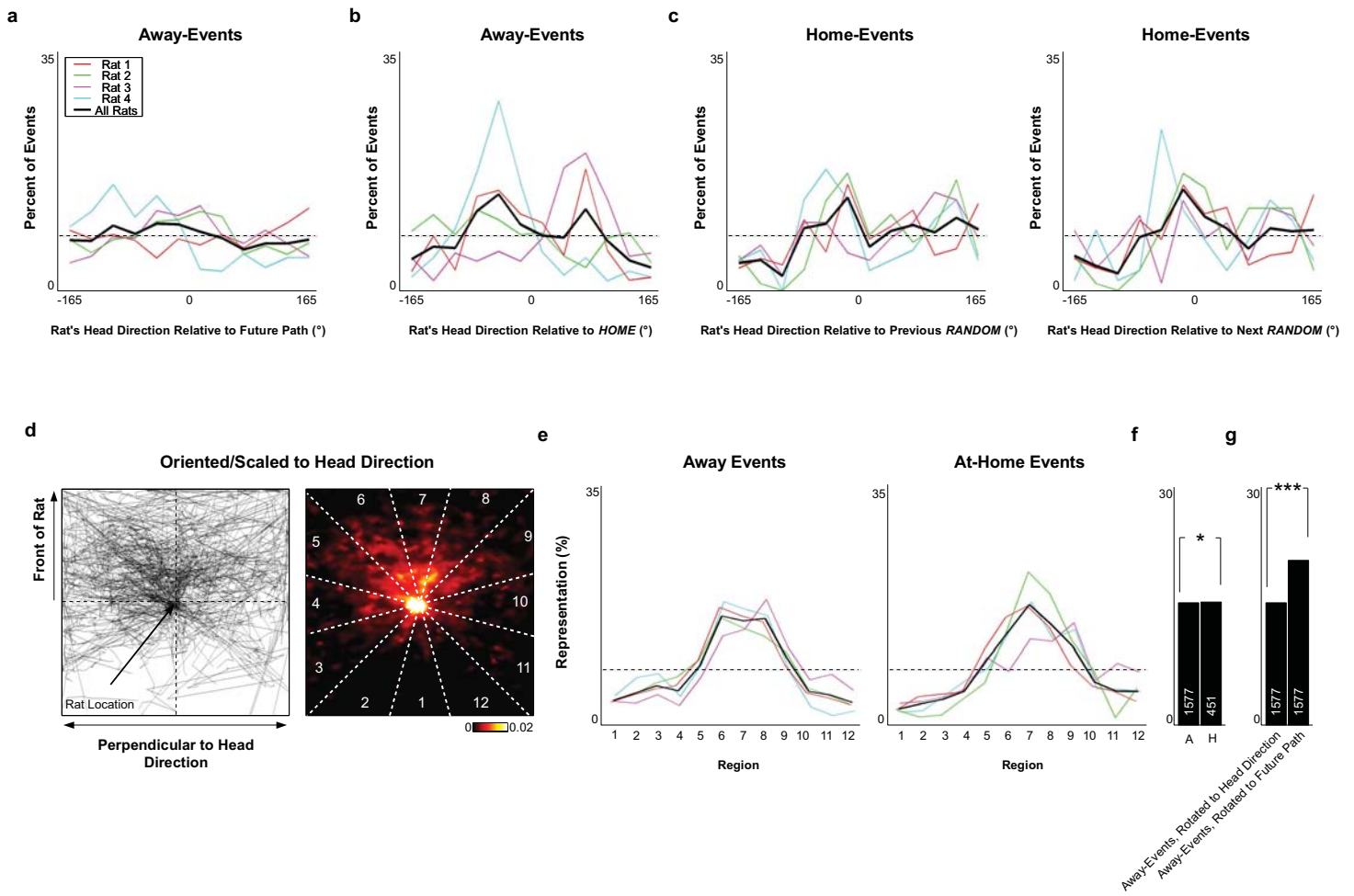
Supplementary Figure 20. Trajectory events compared to the rat's head direction. a, For each away-event, the difference between the rat's head direction at the time of the event and the direction from the rat to the end point of its future path (greater of 10 s or 50 cm) was determined. (A value of 0° means the rat was looking in the same direction as its future path, a value of +/-180° means the rat was looking directly away from its future path.) Plotted is the histogram of events (30° bins, normalized as percent of total of events) with the listed difference in head direction and future path direction. Dashed line indicates chance. **b,** As **a**, but for the difference between the rat's head direction and the direction from the rat to the *HOME* well location. **c,** As **a**, but for the difference between the rat's head direction and the direction from the rat to the previous *RANDOM* well (left) or the future *RANDOM* well (right) for all home-events. **d-f,** As **Supplementary Figure 18a-c**, with events centered by the rat's physical location and rotated according to the rat's head direction at the time of each event and scaled according to the end point of its immediate future path. *P*-value (Wilcoxon rank sum test): 2.1×10^{-2}. **g,** Quantification of region 7 for all away-events rotated to the rat's head direction (**e**, left) or rotated according to the rat's future path (**Supplementary Figure 18b**, left). *P*-value (Wilcoxon rank sum test): 1.4×10^{-9}.

	Candidate Events	Trajectory Events	Percent Confirmed	Duration (ms)	Length (cm)
Rat 1 Day 1	624	274	43.9%	106.1 ± 2.8	69.1 ± 1.5
Rat 1 Day 2	940	373	39.7%	112.1 ± 3.0	68.0 ± 1.3
Rat 2 Day 1	669	254	38.0%	106.7 ± 2.8	65.1 ± 1.4
Rat 2 Day 2	578	237	41.0%	110.8 ± 2.6	67.7 ± 1.5
Rat 3 Day 1	870	298	34.3%	99.8 ± 2.4	67.1 ± 1.4
Rat 3 Day 2	687	189	27.5%	94.9 ± 2.5	63.9 ± 1.6
Rat 4 Day 1	1022	259	25.3%	92.1 ± 2.2	61.5 ± 1.1
Rat 4 Day 2	465	144	31.0%	99.8 ± 2.9	60.5 ± 1.5

Supplementary Table 1. Trajectory Event Statistics. Number of candidate events, confirmed trajectory events, percent of candidate events confirmed as trajectory events, trajectory event duration (mean ± SEM) and trajectory event start-to-end path length (mean ± SEM) for all sessions.

Supplementary Video 1
Behavioral Decoding Accuracy During a Representative Epoch for Rat 1, Day 1.
Supplementary Video 1 demonstrates a representative 30 second epoch for Rat 1, Day 1. The video demonstrates the accuracy of position decoding during behavior. Each frame depicts the predicted position of the rat (posterior probability) within the 2 m x 2 m arena given the unit firing patterns that occurred during that frame. The posterior probabilities are shown as a colormap, which ranges from black (0) to white (0.1). Each frame represents 400 ms, and each frame is advanced from the previous by 100 ms. The rat's physical location and head direction are depicted by the cartoon white rat, and the locations of the 36 wells in the floor of the arena are shown as white squares. The *HOME* well location is colored in cyan. If a *RANDOM* well is active (filled with chocolate) or if the rat is currently at the *RANDOM* well consuming the reward, it is colored in green. If the *HOME* well is active or if the rat is currently at the *HOME* well consuming the reward, the previous *RANDOM* well is colored in red. The time (from the beginning of the session) is depicted at the bottom of the video.

Supplementary Video 2
Representative Trajectory Events Depicted in Figure 2c Demonstrating How The Events Progress Across The Arena Through Time. Supplementary Video 2 shows the trajectory events depicted in **Figure 2c** demonstrating how the events progress across the arena through time. This video depicts three general 'types' of trajectory events: home-events (events which occur while the rat is at the *HOME* well), away-events (events which occur while the rat is away from the *HOME* well) that demonstrate a trajectory that ends at *HOME*, and away-events that demonstrate a trajectory that does not end at or cross *HOME*. Note the wide variety of paths encoded by the trajectory events and the smoothness of the trajectory. Each frame depicts the predicted position of the rat (posterior probability) within the 2 m x 2 m arena given the unit firing patterns that occurred during that frame. The posterior probabilities are shown as a colormap, which ranges from black (0) to white (0.1). Each frame spans 20 ms, and is advanced from the previous by 5 ms. The time from the start of each event is depicted at the bottom of the video. The rat's physical position and head direction throughout each event are depicted by the cartoon white rat, and the locations of the 36 wells in the floor of the arena are shown as white squares. The *HOME* well location is colored in cyan. If a *RANDOM* well is active (filled with chocolate) or if the rat is currently at the *RANDOM* well consuming the reward, it is colored in green. If the *HOME* well is active or if the rat is currently at the *HOME* well consuming the reward, the previously active *RANDOM* well is colored in red. The cyan line connects the peak posterior probabilities for each frame. At the end of each trajectory sequence, the entire event is shown collapsed across time as in **Figure 2c**.

Supplementary Videos 3-7
Representative Episodes Consisting of Both Exploratory Behavior and Trajectory Events.
As **Supplementary Video 1**, but showing representative episodes consisting of both running periods and periods when the rat is stationary and trajectory events are occurring. Successive running and trajectory events within the episode are shown, allowing comparison between paths depicted by trajectory events and those previously and subsequently taken by the animal. During trajectory events, the speed of the video is slowed by a factor of 20 (each frame represents 20 ms, advanced in 5 ms increments) and a solid white border is drawn around the arena to indicate that the decoding is for a trajectory event rather than behavior. Note that each video demonstrates at least one trajectory event that encodes a path from the rat's current location to the *HOME* well shortly before the rat navigates to *HOME* following a strikingly similar path. Each episode occurred during the first 19 trials, when the specific *RANDOM-HOME* combinations were novel.