
Supplementary information

A cellular basis for mapping behavioural structure

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Supplementary Table 1 - Break down of sample numbers in data figures

Figure	Criteria	Mice	Recording Days	Neurons/Neuron pairs
Figure 1 1c-e Extended data 1b, d(left),e,h-k,n-q) Extended data 1c (middle,right) Extended data 1f,g Extended data 1l,m	-All mice -All neuronal mice (mice from which neuronal data was recorded) -All mice that experienced additional ABCD tasks with tone omitted from 50% of trials -All mice that experienced ABCDE tasks	13 (400 tasks) 7 (280 tasks) 3 (26 tasks) 2 (24 tasks)	NA	NA
Figure 2 2f 2g Extended data 2d,e,g Extended data 2f 2h,i Extended data 2i Extended data 2j,k Extended data 3b Extended data 3d-f Extended data 3g,h	-All recorded neurons on days when animal had a repeat session of task X -Concatenated double-days -Concatenated double days -Only goal-progress neurons -Only neurons with at least one significant goal-progress peak -Concatenated double-days -10 or more simultaneously recorded neurons -At least 6 unique tasks -Neuropixels recordings -Concatenated double-days -10 or more simultaneously recorded neurons with no significant spatial tuning in GLM -At least 6 unique tasks -Days with ABCDE tasks -Concatenated double days -State-tuned neurons -Days with ABCD and ABCDE tasks -Concatenated double days -Days with ABCDE tasks -Concatenated double days -10 or more simultaneously recorded neurons	7 7 7 7 2 3 2 2 2	44 days 25 days 25 days 20 days 12 days 8 days 4 days 2 days 4 days	2461 neurons 1252 neurons 873 neurons 1170 neurons 446 neurons 184 neurons 189 neurons 111 neurons 288 neurons

Figure 3 3b	-3 unique tasks -state-tuned neurons	7	X vs Y/Z 50 days X vs X' 37 days	X vs Y/Z 1594 neurons X vs X' 1160 neurons
Extended data figure 4b	-3 unique tasks -state-tuned neurons with state-tuning coefficient higher than 99th percentile of permuted distribution	7	X vs Y/Z 46 days X vs X' 35 days	X vs Y/Z 1061 neurons X vs X' 770 neurons
Extended data figure 4c	-3 unique tasks -state-tuned neurons -only neurons with no discrepancy between "peak-to-peak" angles and "best-rotation" angles	7	X vs Y/Z 41 days X vs X' 31 days	X vs Y/Z 369 neurons X vs X' 240 neurons
Extended data figure 4d	-3 unique tasks -only neurons with no significant spatial tuning in GLM	7	X vs Y/Z 47 days X vs X' 36 days	X vs Y/Z 704 neurons X vs X' 507 neurons
3c; Extended data figure 4h	-3 unique tasks -state-tuned neurons -10 or more simultaneously recorded neurons	7	X vs Y/Z 38 days X vs X' 34 days	X vs Y/Z: 35164 pairs X vs X' 23674 pairs
Extended data figure 4e	-3 unique tasks -state-tuned neurons with state-tuning coefficient higher than 99th percentile of permuted distribution -10 or more simultaneously recorded neurons	7	X vs Y/Z 34 days X vs X' 30 days	X vs Y/Z 17671 pairs X vs X' 11716 pairs
Extended data figure 4f	-3 unique tasks -state-tuned neurons -10 or more simultaneously recorded neurons -only neurons with no discrepancy between "peak-to-peak" angles and "best-rotation" angles	4	X vs Y/Z 16 days X vs X' 12 days	X vs Y/Z: 1642 pairs X vs X' 657 pairs
Extended data figure 4g	-3 unique tasks -10 or more simultaneously recorded neurons with no significant spatial tuning in GLM	4	X vs Y/Z 13 days X vs X' 12 days	X vs Y/Z: 6996 pairs X vs X' 4822 pairs
Extended data figure 4i	-Concatenated double days (6 unique tasks) -state tuned neurons -10 or more simultaneously recorded neurons -more than one site along AP axis (cambridge neurotech probes) -At least 2 pairs coherent along all 6 tasks	4	11 days	3567 pairs
3d	-3 unique tasks -state-tuned neurons -10 or more simultaneously recorded neurons	7	38 days	1434 neurons
Extended data figure 4j	-3 unique tasks -state-tuned neurons	2	12 days	576 neurons

Extended data figure 4k	-Neuropixels recordings -3 unique tasks -state-tuned neurons -Neuropixels recordings -10 or more simultaneously recorded neurons within the same DV bin	2	10 days	5210 pairs *Note that on all included days animals completed 3 unique tasks. On the majority, but not all, of those days animals additionally had a repeat session of task X' at the end of the recording day.
Figure 4 Extended data figure 5	NA	NA	NA	NA
Figure 5 5b,c, Extended data figure 7a,b	-concatenated double-days -All state tuned neurons	7	25	All state-tuned 737 neurons Non-zero lag state tuned 544 neurons* -Distal lag (> 1 state either side of anchor) Non-zero lag state tuned 305 neurons*
Extended data figure 7c,d	-concatenated double-days -All consistently anchored neurons (neurons with the same anchor in >50% of tasks)	7	25	672 neurons
Extended data figure 7f	-concatenated double-days -Neuropixels recordings -Consistently anchored neurons	2	6	247 neurons
Extended data figure 7g	-concatenated double-days -ABCDE days -All state-tuned neurons	2	4	All state-tuned 188 neurons Non-zero lag state tuned 153 neurons* -Distal lag (> 1 state either side of anchor) Non-zero lag state tuned 31 neurons*
5f, Extended data figure 7h,i	-concatenated double-days -All state tuned neurons	7	25	All state-tuned 738 neurons Non-zero lag state tuned 285 neurons* -Distal peak spatial correlation (> 1 state either side of anchor) Non-zero lag state tuned 135 neurons*

5h, Extended data figure 8a,e	-concatenated double-days -State tuned neurons -non-zero regression coefficients	7	25	All state-tuned 489 neurons Non-zero lag state tuned 329 neurons* -Distal peak coefficient (> 1 state either side of anchor) Non-zero lag state tuned 224 neurons*
Extended data figure 8b	-concatenated double-days -All state tuned neurons with state-tuning coefficient higher than 99th percentile of permuted distribution -non-zero regression coefficients	7	25	All state-tuned 349 neurons Non-zero lag state tuned 227 neurons* -Distal peak coefficient (> 1 state either side of anchor) Non-zero lag state tuned 154 neurons*
Extended data figure 8c	-concatenated double-days -State tuned neurons -No trace of tuning to current trajectory -non-zero regression coefficients	7	25	112 neurons
Extended data figure 8d	-concatenated double-days -State tuned neurons -non-zero regression coefficients (Poisson GLM)	7	25	All state-tuned 489 neurons Non-zero lag state tuned 346 neurons* -Distal peak coefficient (> 1 state either side of anchor) Non-zero lag state tuned 229 neurons* *Note: lag from anchor is calculated separately for each analysis method - hence numbers of non-zero lag neurons are different for each method
Figure 6	All panels : -concatenated double days -at least 20 trials to a given anchor (location/goal-progress conjunction) -Only non-zero lag neurons (lag of > 30 degrees in task space either side of anchor) -Consistently anchored neurons (neurons with the same anchor in >50% of tasks) - unless otherwise stated -Firing rate bar-graphs: at least one instance of both anchor visit combinations (e.g. 0:0 and 0:1)			

Extended data 9b	In addition to the above conditions: -All consistently anchored neurons	7	23	355 neurons (0:0,0:1) 131 tasks (1:0,1:1) 123 tasks
6c, Extended data 9c	-All consistently anchored neurons	7	23	355 neurons 131 tasks
Extended data 9d	-Only distal non-zero lag neurons (lag of > 1 state either side of anchor)	7	23	200 neurons (0:0,0:1) 128 tasks (1:0,1:1) 115 tasks
Extended data 9e	-Only neurons anchored to non-rewarded locations -tasks as Ns	7	22	234 neurons (0:0,0:1) 126 tasks (1:0,1:1) 120 tasks
Extended data 9f	-Only neurons anchored to non-rewarded locations -anchorsxtasks as Ns	7	22	234 neurons (0:0,0:1) 821 anchor-tasks (1:0,1:1) 529 anchor-tasks
Extended data 9g	-Only neurons anchored to non-rewarded locations - even if not consistently anchored -Tasks as Ns	7	23	504 neurons (0:0,0:1) 130 tasks (1:0,1:1) 130 tasks
Extended data 9h	-Only neurons anchored to non-rewarded locations - even if not consistently anchored -anchorsxtasks as Ns	7	23	504 neurons (0:0,0:1) 1273 anchor-tasks (1:0,1:1) 826 anchor-tasks
Extended data 9i	-ABCDE days	2	4	110 neurons (0:0,0:1) 24 tasks (1:0,1:1) 24 tasks
Figure 7	All panels: -concatenated double days -All consistently anchored neurons (neurons with the same anchor in >50% of tasks) In addition to the above conditions:			
7c	-All pairs either sharing the same anchor or across anchors	7	24	430 pairs (within) 13932 pairs (between)
7d , Extended data 10a	-All pairs sharing the same anchor	7	24	430 pairs
7e	-All recording days with more than 10 co-anchored pairs in each of the 0-180 and 180-360 forward distance brackets	5	10	59 sleep sessions
Extended data 10b,c	-All pairs sharing the same anchor -session type (pre or post sleep) experienced on a given day	7	24	512 pairs (pre-task) 429 pairs (post-task)

				*pair numbers are averaged across all sleep sessions - hence when sessions are broken down (e.g. to pre and post sleep) the numbers are not exactly equal since not all sleep sessions were sampled on all recording days
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