

Supplementary Materials for

Whiskers aid anemotaxis in rats

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Published 24 August 2016, *Sci. Adv.* **2**, e1600716 (2016)

DOI: 10.1126/sciadv.1600716

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Other Supplementary Material for this manuscript includes the following:

(available at advances.sciencemag.org/cgi/content/full/2/8/e1600716/DC1)

- data file S1 (Microsoft Excel format). Data for Fig. 2 (A and C).
- data file S2 (Microsoft Excel format). Data for Fig. 3 (B and C).
- movie S1 (.mp4 format). The video shows 13 trials in which a rat localizes airflow emanating from one of five fans, arranged around the circumference of a table.

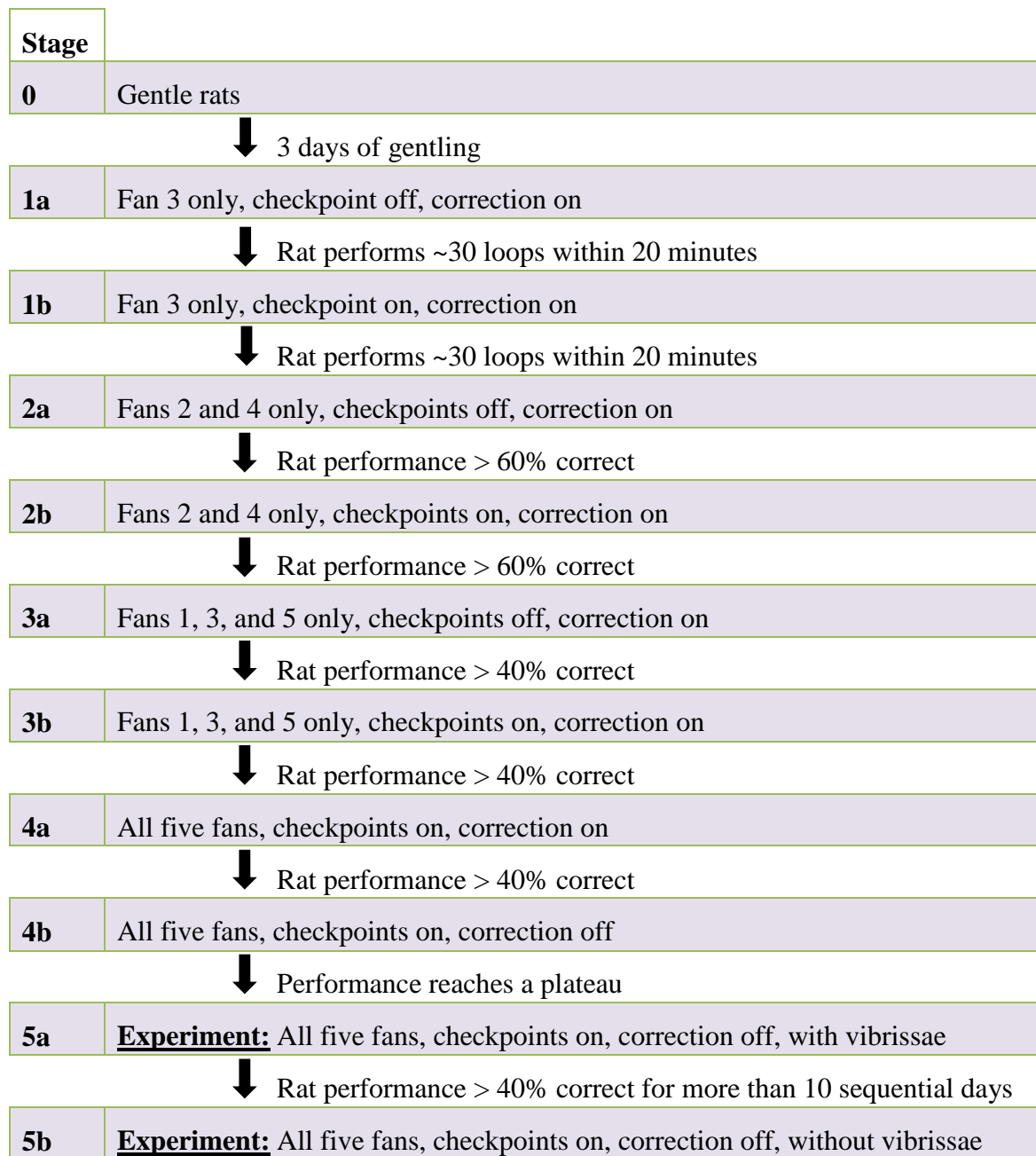


fig. S1. Rats learned to perform the task through a series of behavioral shaping stages. Rats were trained in four stages of increasing difficulty. In stages 1 to 4 the number of fans was gradually increased from a single fan to five fans. Fans were added symmetrically about fan 3. Each stage was composed of two sub-stages to adjust the difficulty of the task. The criteria for stage advancement were adjusted to reflect the difficulty of the training stage. Stage 5a marks the beginning of the experiment and was determined retroactively to begin when the rat performed greater than 40% for 10 consecutive days with an average performance above 55%. In stage 5b vibrissae were cut off and the experiment was performed for an additional 10 days.

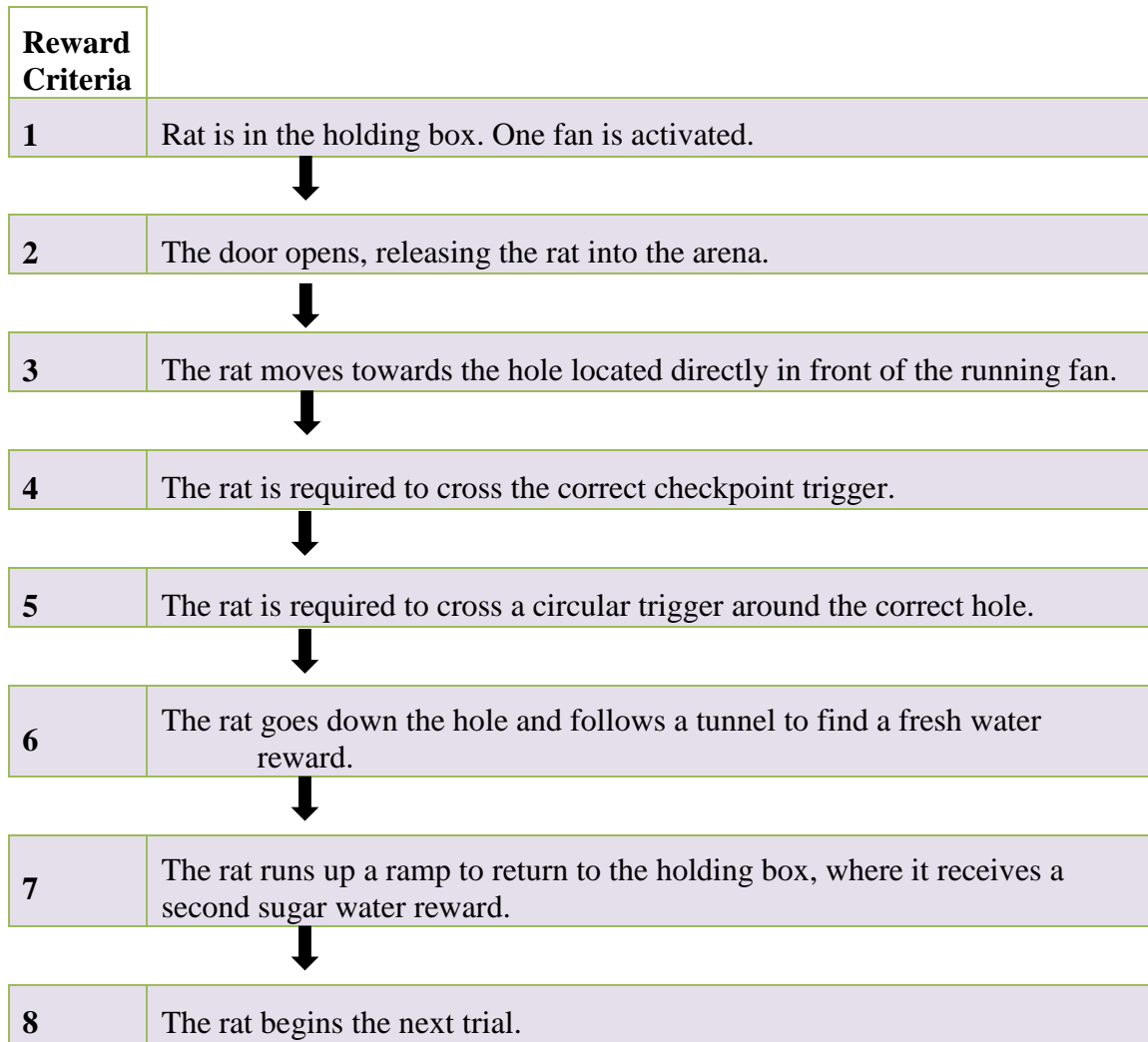


fig. S2. Reward delivery was contingent on performance. (1) The rat started in the holding box and one of the five fans was activated. (2) After a ten second delay, the motorized door lifted automatically. (3) The rat left the holding box and ran towards the airflow source. (4) To prevent the rat from making a choice close to the fan, it was required to cross the checkpoint trigger before (5) reaching the hole corresponding to the activated fan. Note that when the rat reached any of the hole triggers, the fan was turned off and the holding box door was shut. In cases when the rat failed (chose either the first or second trigger incorrectly, or both), all rewards were withheld, but the rat was allowed to navigate through the tunnels as normal. (6) Upon the successful completion of steps 1 - 5 a solenoid valve opened beneath the table, making an audible click and releasing a fresh water reward. The rat travelled down the hole and through a tunnel system to the reward. (7) The rat then traversed a ramp back to the holding box to complete the trial and receive a second sugar water reward. The second reward was contingent upon the rat having received the first reward. (8) The rat started another trial. This process was repeated for a minimum of 45 trials per day per rat. For control rats, fans were replaced with LEDs.

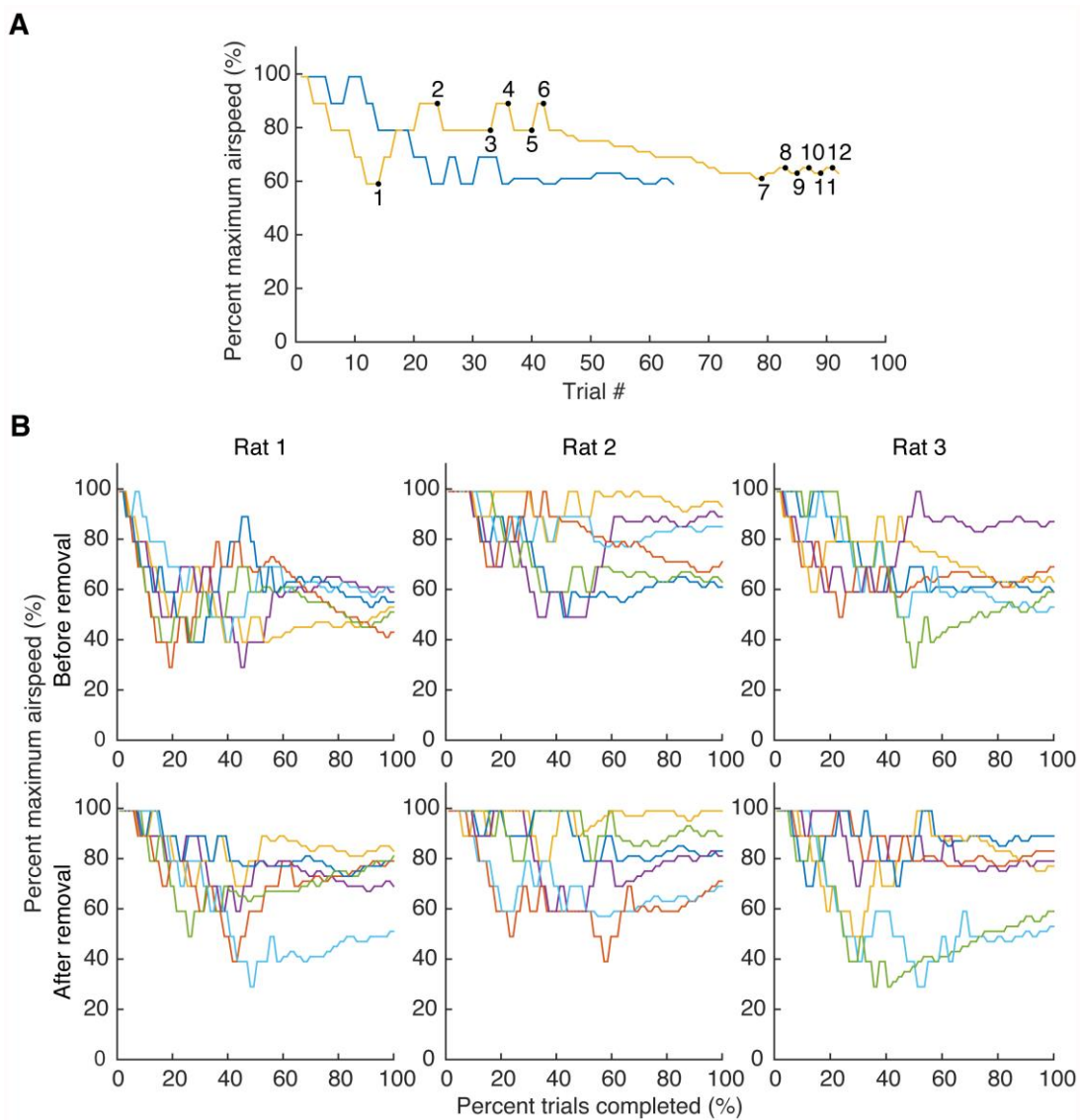


fig. S3. Fan speed was adjusted to determine rat localization thresholds. (A) Two days of typical performance of Rat 3 on the 2-up/2-down threshold experiment. Reversals for one day are labeled (black dots). Percent of maximum fan speed is shown as a function of trial number. **(B)** Performances of Rats 1, 2, and 3 six days before and six days after vibrissal removal are shown. Percent of maximum fan speed is shown as a function of percent trial completed. Days used are listed in table S3. Sequential days are color coded: blue; red; yellow; purple; green; cyan.

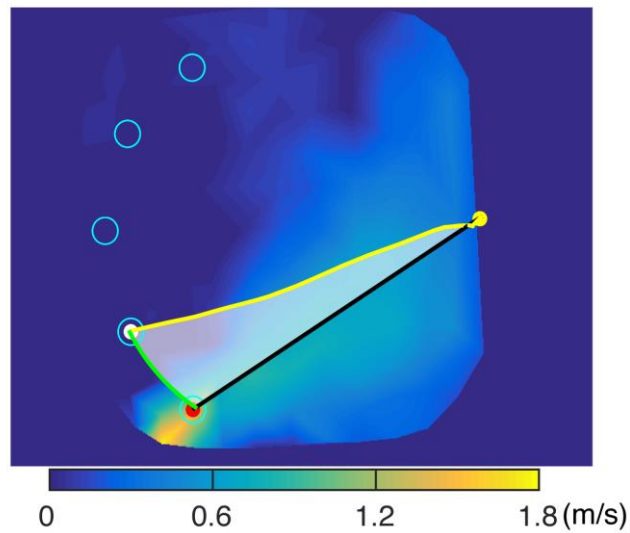


fig. S4. Path length deviation was quantified on the basis of the rat's trajectory. The deviation was computed as the area enclosed by the straight-line path from the door to the activated fan (black line connecting the yellow dot to the red dot), the actual trajectory taken by the rat to the incorrect fan (yellow curve connecting yellow dot to white dot), and the arena boundary (green curve), divided by the length of the straight-line path.

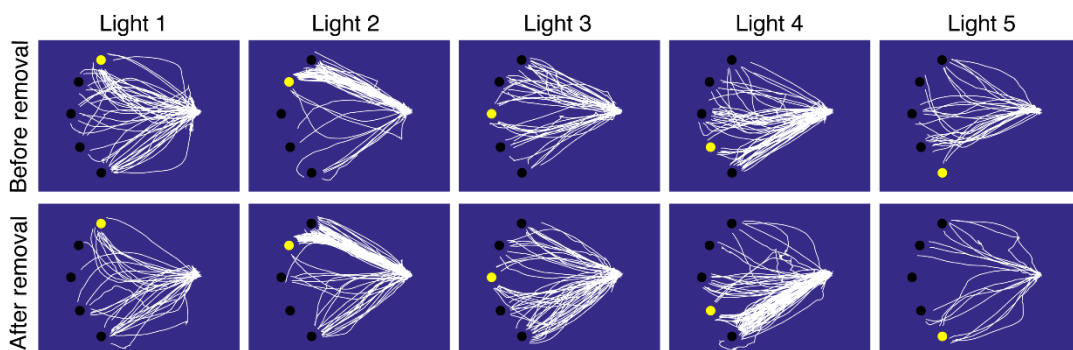


fig. S5. Vibrissal removal does not affect the rats' ability to find a light source. Trajectories of all incorrect trials for all three rats trained to localize a light source on the ten days before (top row) and after vibrissal removal (bottom row). Trajectories show equal deviation from the ideal straight-line path before and after vibrissal removal.

table S1. Descriptive statistics for locomotion. No significant changes by group were observed in locomotor speed, number of pauses, or duration of pauses as the rats traversed the arena before and after whisker removal. A 0.075 m/s lower bound was imposed to exclude pauses from the locomotor speed analysis. Similarly, the minimum measurable duration of 50 ms (determined by the camera frame rate) imposed a *de facto* lower bound for the pause duration analysis.

	Group	Min.	Lower quartile	Median	Upper quartile	Max.	Skewness	Kurtosis
Locomotor speed (m/s)								
Before removal	Airflow	0.075	0.3450	0.8583	1.5405	5.3155	1.0428	3.6063
	Light	0.075	0.2510	0.7450	1.4405	5.2457	1.1565	3.8733
After removal	Airflow	0.075	0.3593	0.8347	1.4753	4.5891	1.052	3.6672
	Light	0.075	0.2454	0.6957	1.3971	4.8058	1.2167	4.0061
Number of pauses								
Before removal	Airflow	1	9	20	34	48	0.3868	1.8570
	Light	7	18	23.5	44	52	0.2166	1.6614
After removal	Airflow	3	8	12.5	36	48	0.5863	1.6860
	Light	16	21	32	46	57	0.3588	1.8714
Duration of pauses (s)								
Before removal	Airflow	0.05	0.25	0.55	1.10	18.1	5.1178	47.8660
	Light	0.05	0.4	0.75	1.5	29.7	6.5809	72.5227
After removal	Airflow	0.05	0.3	0.55	1.1	19.95	6.5353	64.3533
	Light	0.05	0.3	0.65	1.55	32.55	5.9915	61.8888

table S2. Median values of the performance and deviation data. The Wilcoxon rank-sum test checks for differences in the median values. The trends in seen in the median values are similar to those expressed by the mean values shown in Figs. 2 and 3.

Median performance values (%)		
	Before vibrissal removal	After vibrissal removal
Rat 1	61.17	60.98
Rat 2	67.44	46.50
Rat 3	62.50	55.60
Rat 4	56.32	46.02
Rat 5	57.67	43.18
Rat 6	82.68	79.33
Rat 7	72.08	69.60
Rat 8	82.89	84.87
Median deviation values (cm)		
	Before vibrissal removal	After vibrissal removal
Rat 1	111.31	119.37
Rat 2	106.31	133.73
Rat 3	101.17	126.54
Rat 4	106.09	126.01
Rat 5	133.91	147.76
Rat 6	145.41	170.81
Rat 7	116.09	125.71
Rat 8	139.04	100.84

table S3. Completion criteria for the localization threshold experiment vary by rat. For rat 2, only the shaded days were used in the analysis.

Rat 1				
	Before vibrissal removal		After vibrissal removal	
Day	Number of reversals at 10% + number of reversals at 2%	Total number of trials	Number of reversals at 10% + number of reversals at 2%	Total number of trials
1	6+7	93	6+6	66
2	6+3	106	6+6	67
3	6+5	64	6+6	63
4	6+6	87	6+6	72
5	6+6	87	6+5	93
6	6+6	76	6+5	83
Rat 2				
	Before vibrissal removal		After vibrissal removal	
Day	Number of reversals at 10% + number of reversals at 2%	Total number of trials	Number of reversals at 10% + number of reversals at 2%	Total number of trials
1	6+3	61	6+6	50
2	6+7	68	6+5	82
3	6+5	88	2+0	25
4	5+0	47	6+5	80
5	6+6	63	6+4	75
6	6+0	57	6+7	78
7	6+7	69	3+0	35
8	6+6	61	2+0	41
9	6+1	64	6+6	69
10	6+6	54	6+1	91
Rat 3				
	Before vibrissal removal		After vibrissal removal	
Day	Number of reversals at 10% + number of reversals at 2%	Total number of trials	Number of reversals at 10% + number of reversals at 2%	Total number of trials
1	6+6	64	6+6	87
2	6+6	82	6+6	63
3	6+6	92	6+6	96
4	6+6	67	6+6	82
5	6+6	93	6+6	101
6	6+6	81	6+6	80

movie S1. The video shows 13 trials in which a rat localizes airflow emanating from one of five fans, arranged around the circumference of a table. The trials are not sequential; they were chosen to give examples of typical behaviors. All trials are from the same rat on the same day. The left video shows the view obtained from the overhead camera (20 fps). The activated fan is labeled “ON.” The right video shows an interpolated airspeed colormap projected onto the table, with the trajectory of the tracked rat overlaid. Airspeed is in m/s.