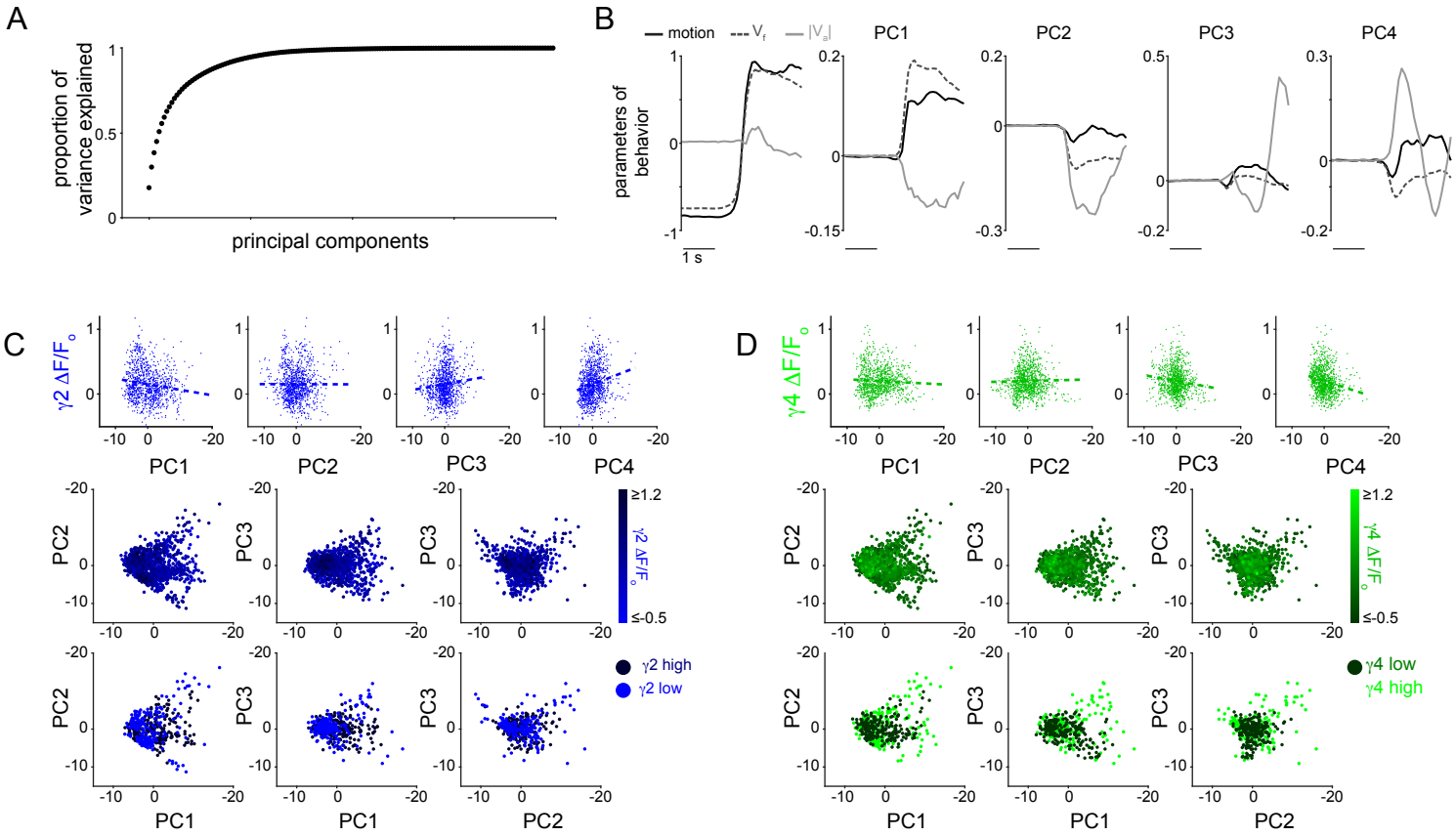
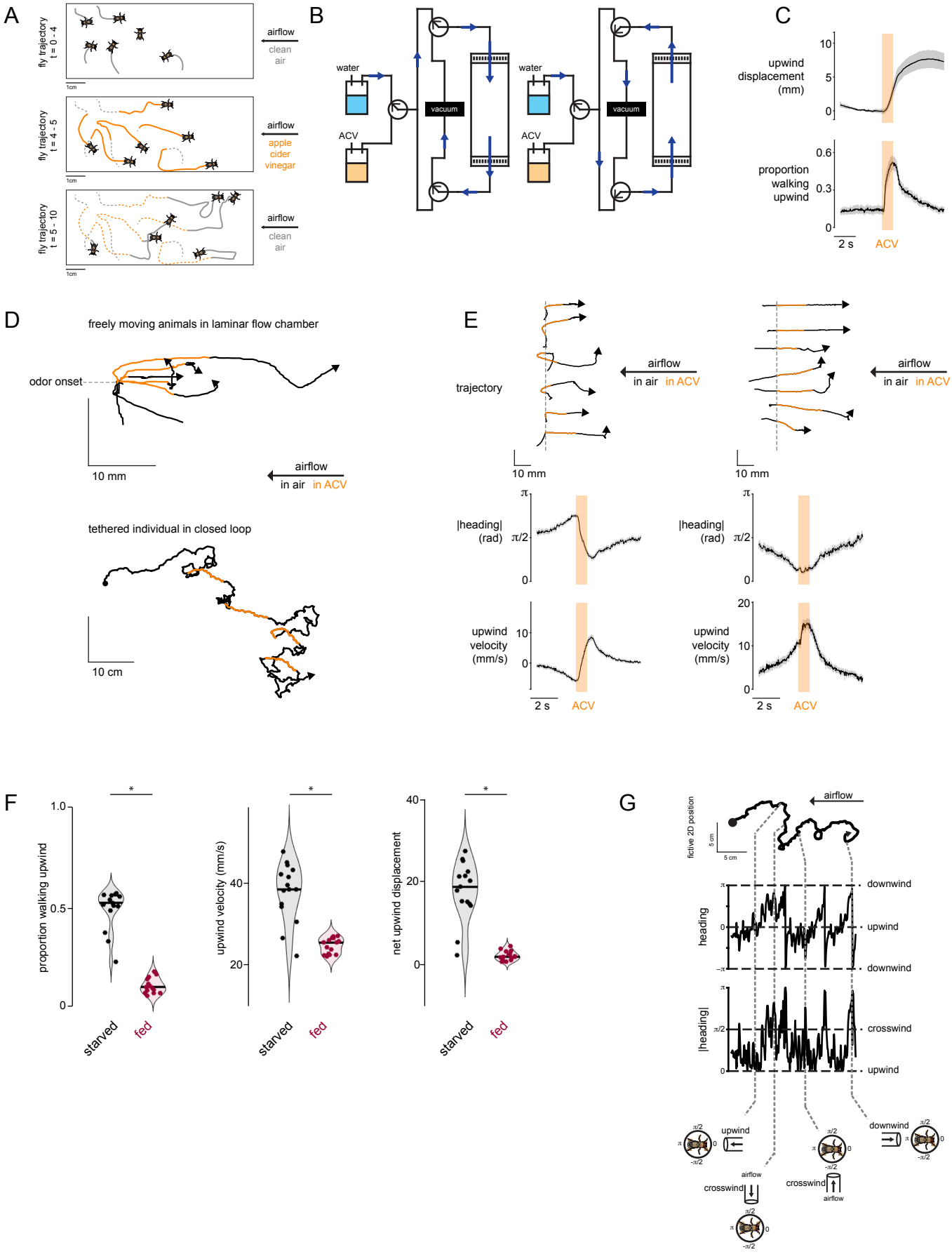
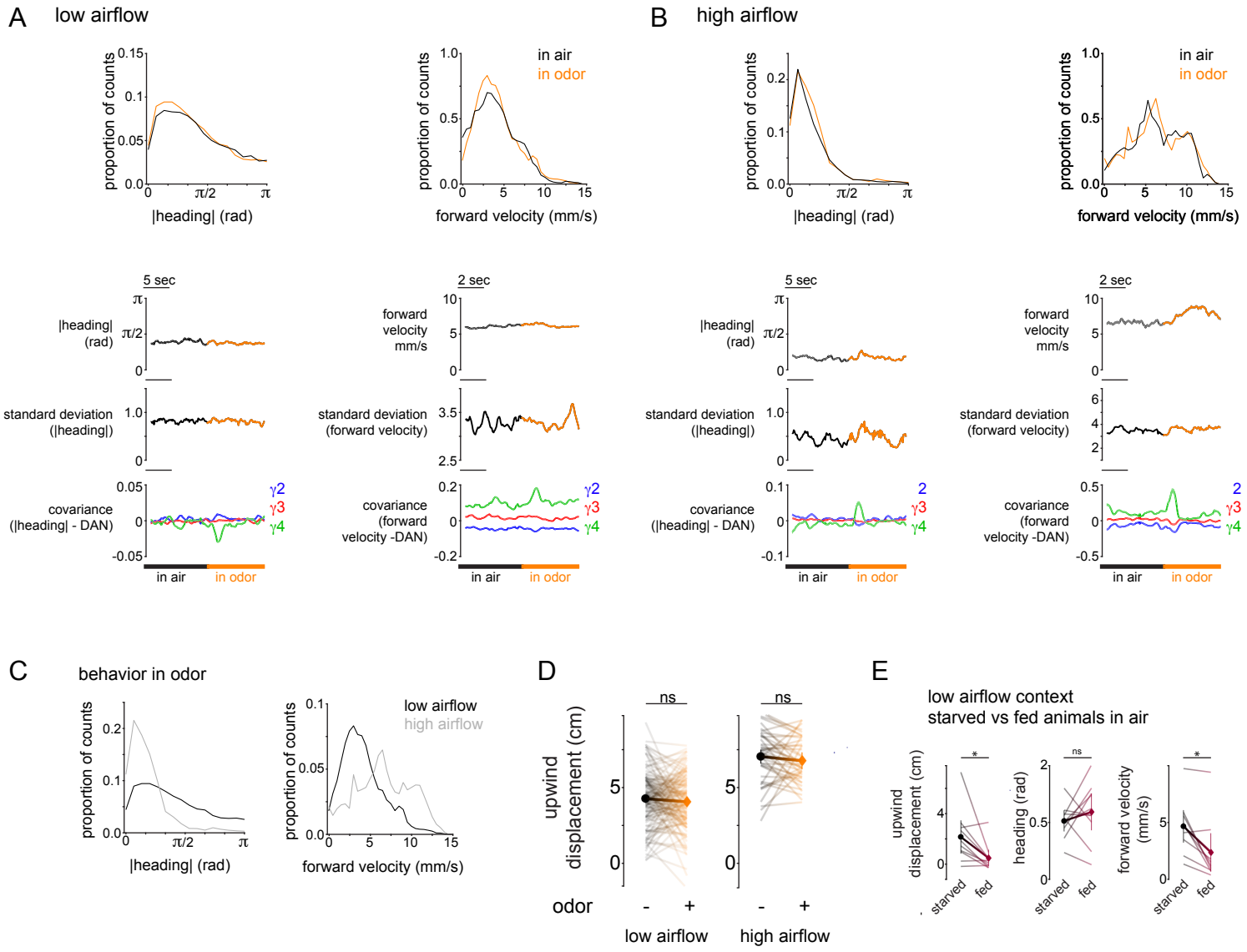


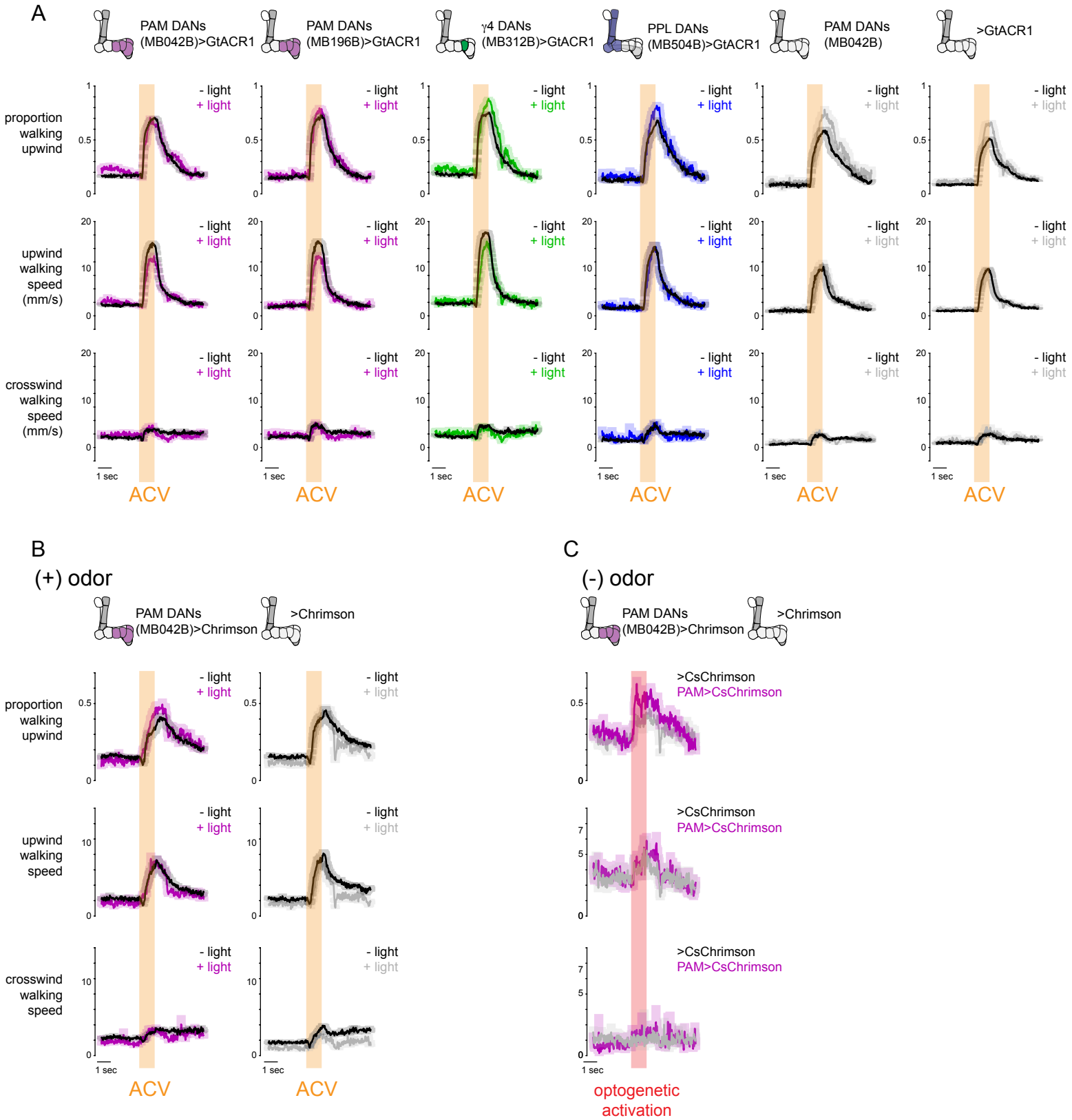
Supplementary Figure 1. Principal component analysis (PCA) of behavioral variables during the onset of movement. PCA was performed on net motion, forward velocity, |angular velocity|, and |lateral velocity| across a 4 second time window centered on instances of movement initiation (4 variables × 4 sec time window × 10Hz sampling = 160 initial variables per start). All behaviors were z-score normalized over the 4 sec window. **(A)** Proportion of variance explained by each additional principal component (PC) in the PCA. **(B)** Most significant PCs. Left panel: mean z-score normalized behavioral variables during movement onset. Right panels: top 4 PCs along which the behavioral data maximally vary. **(C)** and **(D)** Relationship between most significant PCs and γ2 (G) and γ4 (H) $\Delta F/F_o$ (averaged during the 2 sec interval after movement onset). (C) Average γ2 $\Delta F/F_o$ as a function of the top four PCs (top row). All Pearson correlation coefficients are either weak ($|r|<0.2$) or not significant. Pairwise comparison of top three PCs as a function of γ2 $\Delta F/F_o$ for all movement initiations (middle row) and bouts with the highest and lowest 25% of γ2 $\Delta F/F_o$ (bottom row). **(D)** As in (C) but for γ4. All Pearson correlation coefficients are either weak ($|r|<0.2$) or not significant. p values not adjusted with Bonferroni correction.


A
fly trajectory t = 0 - 4
airflow
clean air
fly trajectory t = 4 - 5
airflow
apple cider vinegar
fly trajectory t = 5 - 10
airflow
clean air
1cm
B
water
ACV
vacuum
water
ACV
vacuum
C
upwind displacement (mm)
10
5
0
proportion walking upwind
0.6
0.3
0
2 s
ACV
D
freely moving animals in laminar flow chamber
odor onset
10 mm
airflow
in air in ACV
tethered individual in closed loop
10 cm
E
trajectory
airflow
in air in ACV
10 mm
|heading| (rad)
π
π/2
0
upwind velocity (mm/s)
10
0
2 s
ACV
20
F
proportion walking upwind
1.0
0.5
0
*
starved
fed
upwind velocity (mm/s)
40
20
net upwind displacement
40
20
0
G
airflow
fictive 2D position
5 cm
heading
downwind
upwind
|heading|
crosswind
upwind
downwind
crosswind
airflow

Supplementary Figure 2. Behavioral responses to the appetitive food odor, apple cider vinegar, in closed-loop are similar to those in freely moving flies. (A) Schematic of experimental paradigm in which the movements of a cohort of 5-7 flies in a laminar flow chamber were measured prior to, during, and after presentation of the appetitive food odor apple cider vinegar (ACV). **(B)** Schematic of laminar flow chamber and valve system to reverse the direction of air flow and ACV during alternating trials. **(C)** Average upwind displacement (top) and proportion of starved animals walking upwind (bottom) ± 95% confidence interval prior to, during (orange bar), and after a 1 sec pulse of ACV in the behavioral chamber aligned to the onset of odor. N=15 experiments using cohorts of 6 flies, 300 odor presentations. **(D)** Trajectories of freely moving and tethered flies during odor-gated anemotaxis. Top: untethered flies in the behavioral chamber aligned to a common origin at the onset of a 1 sec presentation of ACV (orange). Trajectories 1 sec before and 2 sec after odor are in black. Bottom: Fictive 2D trajectory of representative tethered fly walking in the closed-loop system in response to four 10-sec presentations of ACV over a 5 min trial. **(E)** Top: behavioral responses of individual flies to ACV walking crosswind (left, N=637) or upwind (right, N=224) at the time of odor onset. Bottom: average ± 95% confidence interval |heading| and upwind velocity aligned to odor onset (orange bar) for all flies. **(F)** Proportion of flies walking upwind (left), average upwind velocity (middle), and average net upwind displacement (right) of animals starved for 12-18 hours (black) and fed animals (maroon) during a 1 sec presentation of ACV. Unpaired two-sided t-test with Bonferroni correction, $p<10^{-4}$ (*), see Supplementary Table 1. N=15 cohorts of 6 animals, 300 odor presentations. **(G)** Animal heading (middle) and |heading| (bottom) aligned to fictive 2D trajectory (top row) of a representative tethered individual walking in closed-loop paradigm. Bottom: the position of the air tube relative to tethered fly on the treadmill at indicated orientations.



Supplementary Figure 3. Comparison of behavior in high and low airflow, in clean air and odor. (A) Top: distribution of time animals were oriented at a particular heading angle (left) or moved at a given forward velocity (right) in (orange) and out (black) of odor in the closed-loop paradigm under low airflow conditions. No significant difference in variance by 2-sampled F-test (p(|heading|) = 0.1318; p(forward velocity) = 0.0508). Bottom, left: average |heading| (top), standard deviation (SD) of |heading| (middle), and covariance of |heading| and DAN activity (bottom) at the onset of odor (low airflow conditions). Average |heading| and covariance plotted ± 95% confidence interval (obscured by the thickness of the data line). Increase in covariance corresponds to the initial reorientation of animals. N=26 flies, 143 odor presentations. Right: same analysis as left but for forward velocity. **(B)** As in (A), but under high airflow conditions. Top: No significant difference in variance by 2-sampled F-test (p(|heading|) = 0.0991; p(forward velocity) = 0.0764). Bottom: the increase in covariance corresponds to the initial acceleration of animals in odor. N=22 flies, 52 odor presentations. **(C)** Distribution of time tethered animals were oriented at a particular heading angle (left) or moved at a given forward velocity (right) in the closed-loop paradigm in the low (black) or high airflow (gray) context. Difference in variance in vs out of odor is significant by 2-sampled F-test (p(|heading|)<0.0001; p(forward velocity)<0.0001). **(D)** Average upwind displacement in (orange) and out (black) of odor in low (right) and high (left) airflow. No significant differences by paired t-test with Bonferroni correction. Low airflow: N=26 flies, 143 odor presentations. High airflow: N=22 flies, 52 odor presentations. **(E)** Upwind displacement (left), average |heading| (middle), and average forward velocity (left) of animals prior to (black, starved) and after (maroon, fed) a sucrose meal walking in odorless air (as in Figure 5B). Paired two-sided t-test with Bonferroni correction, p<0.05 (*), see Supplementary Table 1. N=10 flies, 102 bouts (49 before and 53 after feeding).


A
PAM DANs (MB042B)>GtACR1
PAM DANs (MB196B)>GtACR1
γ4 DANs (MB312B)>GtACR1
PPL DANs (MB504B)>GtACR1
PAM DANs (MB042B)
>GtACR1
proportion walking upwind
upwind walking speed (mm/s)
crosswind walking speed (mm/s)
- light
+ light
1 sec
ACV
B
(+) odor
PAM DANs (MB042B)>Chrimson
>Chrimson
proportion walking upwind
upwind walking speed
crosswind walking speed
- light
+ light
1 sec
ACV
C
(-) odor
PAM DANs (MB042B)>Chrimson
>Chrimson
>CsChrimson
PAM>CsChrimson
1 sec
optogenetic activation

Supplementary Figure 4. Odor-evoked amenotaxis during optogenetic inhibition or excitation of PAM DANs. (A) Proportion of individuals walking upwind (top row), average upwind walking speed (middle row), and average crosswind walking speed (bottom row), ± 95% confidence interval (shaded area), of cohorts of animals in the behavioral chambers aligned to odor presentation during trials preceding optogenetic inhibition (-, black) and in the trial paired with optogenetic inhibition (+, colored) for the indicated genotypes in starved animals. PAM DANs (MB042B driver)>GtACR1 (N=63, 1st column), PAM DANs (MB196B driver)>GtACR1 (N=49, 2nd column), γ4 DANs (MB312B driver)>GtACR1 (N=54, 3rd column), PPL DANs (MB504B driver)>GtACR1 (N=30, 4th column), PAM DANs MB042B-Gal4 parental controls (N=33, 5th column), UAS-GtACR1 parental controls (N=48, 6th column). **(B)** Proportion of individuals walking upwind (top row), average upwind walking speed (middle row), and average crosswind walking speed (bottom row), ± 95% confidence interval (shaded area), of cohorts of animals in the behavioral chambers aligned to odor presentation during trials preceding optogenetic excitation (-, black) and in the trial paired with optogenetic excitation (+, colored) for the indicated genotypes in fed flies. PAM DANs (MB042B driver)>CsChrimson flies (left) and UAS-Chrimson parental controls (right). N=60 paired cohorts of PAM>CsChrimson and parental control animals assayed together during a single experiment. **(C)** Proportion of individuals walking upwind (top row), average upwind walking speed (middle row), and average crosswind walking speed (bottom row), ± 95% confidence interval (shaded area), of cohorts of animals in the behavioral chambers aligned to light exposure in PAM DANs (MB042B driver)>CsChrimson flies (magenta) and UAS-CsChrimson parental controls (gray). N=44 paired cohorts.

Supplementary Table 1: Fly Stocks and Genotypes

Fly stocks and sources

Fly Genotype	**Source**
UAS-sytGCaMP6s	Cohn, R., *et al*., *Cell* **163**, 1742–1755 (2015).
TH-Gal4	Friggi-Grelin, F., *et al*., *Genesis* **35**, 260-269 (2003).
DDC-Gal4	Li, H. *et al*., *Curr Biol.* **10**, 211-214 (2000).
MB247-DsRed	Riemensperger, T. *et al*., *Curr. Biol*. **15**, 1953–1960 (2005).
UAS-GCaMP6f	Bloomington Stock Center, No. 42747
MB247-LexA	Pitman, J.L., *et al*., *Curr. Biol*. **21**, 855–861(2011).
LexAop-GCaMP6s	Bloomington Stock Center, No. 53747
MB042B	Bloomington Stock Center, No. 68303
MB312B	Bloomington Stock Center, No. 68314
MB316B	Bloomington Stock Center, No. 68317
MB504B	Bloomington Stock Center, No. 68329
MB196B	Bloomington Stock Center, No. 68271
MB441B	Bloomington Stock Center, No. 68251
20X-UAS-IVS-CsChrimson.mVenus-attP18	Bloomington Stock Center, No. 55134
20X-UAS-GtACR1.EYFP-attP40	Mohammad, F., *et al*., *Nat Methods* **14,** 271–274 (2017).
58E02-lexA	Bloomington Stock Center, No. 52740
13XLexAop2-IVS-NES-jRGECO1a-p10 in attP5	Bloomington Stock Center, No. 64426
10X-UAS-IVS-Op-dLight1.3b-p10 in attP2	Gift of Lin Tian, Chuntao Dan, and Vivek Jayaraman
OK107-Gal4	Bloomington Stock Center, No. 854

Fly genotypes by figure

Figure	**Fly Genotype**
Figures 1B,C, 2, 3B-F, 4, 5B-E, 6, Extended Data Figures 1B,C, 3A-G, 4, 5, 6, 7, 8, 9, Supplementary Figure 1, 2D,G, 3	UAS-sytGCaMP6s, MB247(KCs)-DsRed; TH(DAN subset)-Gal4, DDC(DAN subset)-Gal4
Figure 1B,D and Extended Data Figure 1B,D	UAS-dLight1.3b; OK107(KCs)-Gal4
Figure 1E,F	58E02(DAN subset)-LexA/LexAop-GCaMP6f; OK107(KCs)-Gal4/UAS-jRGECO
Figure 7A,B	UAS-GtACR1; 58E02(DAN subset)-p65ADZp; 22E04(DAN subset)-ZpGdbd (MB042B)
Figure 7C, Extended Data Figure 10A, and Supplementary Figure 4A	UAS-GtACR1; 58E02(DAN subset)-p65ADZp; 22E04(DAN subset)-ZpGdbd (MB042B) UAS-GtACR1; 58E02(DAN subset)-p65ADZp; 36B06(DAN subset)-ZpGdbd (MB196B) +/+; 58E02(DAN subset)-p65ADZp; 22E04(DAN subset)-ZpGdbd (MB042B) UAS-GtACR1; 52H03(DAN subset)-p65ADZp; TH(DAN subset)-ZpGdbd (MB504B) UAS-GtACR1; 58E02(DAN subset)-p65ADZp; 10G03(DAN subset)-ZpGdbd (MB312B) UAS-GtACR1; +/+; +/+
Figure 7D, Extended Data Figure 10B, and Supplementary Figure 4B,C	UAS-CsChrimson; 58E02(DAN subset)-p65ADZp; 22E04(DAN subset)-ZpGdbd (MB042B) UAS-CsChrimson; +/+; +/+
Extended Data Figure 1F-H (top) and Extended Data Figure 2A,C,E,G:	58E02(DAN subset)-p65ADZp/UAS-GCaMP6f; 10G03(DAN subset)-ZpGdbd (MB312B)
Extended Data Figure 1F-H (bottom) and Extended Data Figure 2B,D,F:	58E02(DAN subset)-p65ADZp/UAS-GCaMP6f; 93G08 (DAN subset)-ZpGdbd (MB316B)
Extended Data Figure 3H:	MB247(KCs)-LexA/LexAOP-GCaMP6s

Supplementary Table 2: Statistical Analyses

One-way ANOVA followed by Tukey's multiple comparison test.

Figure		sum of the squares	degrees of freedom	mean squared error	*F*-statistic	*p*-value
Figure 2C	columns	1.36046	3	0.45349	26.08	1.17327×10^{-12}
	errors	1.80873	104	0.01739		
	total	3.16919	107			
Extended Data Figure 3H	columns	0.0002	2	0.0001	0.18	0.8376
	errors	0.0258	45	0.00057		
	total	0.026	47			
Extended Data Figure 4F	columns	94.323	47.1614	1184.31		1.8246×10^{-196}
	errors	21.145	0.0398			
	total	533				
Extended Data Figure 4G (left)	columns	0.03773	4	0.00943	204.95	6.4872×10^{-77}
	errors	0.01128	245	0.00005		
	total	0.04901	249			
Extended Data Figure 4G (middle)	columns	0.584	4	0.146	396.21	1.139010^{-105}
	errors	0.09028	245	0.00037		
	total	0.67427	249			
Extended Data Figure 4G (right)	columns	0.0456	4	0.0114	327.43	5.1709×10^{-97}
	errors	0.00853	245	0.00003		
	total	0.05413	249			

Pearson Correlation Coefficient

Figure	context	variable 1	variable 2	correlation coefficient (r)	*p*-value
Figure 1F	spontaneous movement	γ4 DAN GCaMP	γ4 KC dLight	0.8716	$<10^{-20}$
Figure 1F	spontaneous movement	γ5 DAN GCaMP	γ5 KC dLight	0.8649	$<10^{-20}$
Figure 3C	low airflow	upwind displacement	Δ|heading|	-0.5900	9×10^{-15}
	low airflow	upwind displacement	Δforward velocity	0.3129	0.0001
Figure 3F	low airflow	upwind displacement	$\gamma 2\ \Delta F/F_o$	-0.3464	2.25×10^{-5}
	low airflow	upwind displacement	$\gamma 3\ \Delta F/F_o$	-0.1953	0.0194
	low airflow	upwind displacement	$\gamma 4\ \Delta F/F_o$	0.4971	2.7×10^{-10}
	low airflow	Δ|heading|	$\gamma 2\ \Delta F/F_o$	0.3501	1.8×10^{-5}
	low airflow	Δ|heading|	$\gamma 3\ \Delta F/F_o$	0.1586	0.0585
	low airflow	Δ|heading|	$\gamma 4\ \Delta F/F_o$	-0.5582	4.37×10^{-13}
	low airflow	Δforward velocity	$\gamma 2\ \Delta F/F_o$	0.1561	0.0627
	low airflow	Δforward velocity	$\gamma 3\ \Delta F/F_o$	0.1518	0.0703
	low airflow	Δforward velocity	$\gamma 4\ \Delta F/F_o$	0.0906	0.2821
Figure 4B	high airflow	upwind displacement	Δ|heading|	-0.5849	5.28×10^{-6}
	high airflow	upwind displacement	Δforward velocity	0.7758	1.4×10^{-11}
Figure 4D	high airflow	upwind displacement	$\gamma 2\ \Delta F/F_o$	-0.2522	0.0712
	high airflow	upwind displacement	$\gamma 3\ \Delta F/F_o$	-0.1082	0.4451
	high airflow	upwind displacement	$\gamma 4\ \Delta F/F_o$	0.4670	0.0005
	high airflow	Δ|heading|	$\gamma 2\ \Delta F/F_o$	0.0892	0.5294
	high airflow	Δ|heading|	$\gamma 3\ \Delta F/F_o$	0.1180	0.4049
	high airflow	Δ|heading|	$\gamma 4\ \Delta F/F_o$	-0.2978	0.0320
	high airflow	Δforward velocity	$\gamma 2\ \Delta F/F_o$	-0.3840	0.005
	high airflow	Δforward velocity	$\gamma 3\ \Delta F/F_o$	-0.1199	0.3973
	high airflow	Δforward velocity	$\gamma 4\ \Delta F/F_o$	0.6143	1.27×10^{-6}
Figure 5B	low airflow (model-generated)	upwind displacement	γ2 (z score)	-0.7702	$<10^{-15}$
	low airflow (model-generated)	upwind displacement	γ3 (z score)	-0.5079	9.5×10^{-11}
	low airflow (model-generated)	upwind displacement	γ4 (z score)	0.8461	$<10^{-15}$
	low airflow (model-generated)	|heading|	γ2 (z score)	0.9160	$<10^{-15}$

	low airflow (model-generated)	|heading|	$\gamma 3$ (z score)	0.6577	$<10^{-15}$
	low airflow (model-generated)	|heading|	$\gamma 4$ (z score)	-0.8575	$<10^{-15}$
	low airflow (model-generated)	forward velocity (normalized)	$\gamma 2$ (z score)	0.0649	0.4415
	low airflow (model-generated)	forward velocity (normalized)	$\gamma 3$ (z score)	0.2952	$3.4x10^{-4}$
	low airflow (model-generated)	forward velocity (normalized)	$\gamma 4$ (z score)	0.4426	$3.1x10^{-8}$
	low airflow (experimental)	upwind displacement	$\gamma 2$ (z score)	-0.4187	$1.9x10^{-7}$
	low airflow (experimental)	upwind displacement	$\gamma 3$ (z score)	-0.2376	0.0043
	low airflow (experimental)	upwind displacement	$\gamma 4$ (z score)	0.4431	$3.0x10^{-8}$
	low airflow (experimental)	|heading|	$\gamma 2$ (z score)	0.4475	$2.1x10^{-8}$
	low airflow (experimental)	|heading|	$\gamma 3$ (z score)	0.1802	0.0313
	low airflow (experimental)	|heading|	$\gamma 4$ (z score)	-0.4669	$4.2x10^{-9}$
	low airflow (experimental)	forward velocity (normalized)	$\gamma 2$ (z score)	0.1932	0.0208
	low airflow (experimental)	forward velocity (normalized)	$\gamma 3$ (z score)	0.0748	0.37451
	low airflow (experimental)	forward velocity (normalized)	$\gamma 4$ (z score)	0.0929	0.2700
Figure 5C	high airflow (model-generated)	upwind displacement	$\gamma 2$ (z score)	-0.2481	0.1178
	high airflow (model-generated)	upwind displacement	$\gamma 3$ (z score)	-0.6631	$2.3x10^{-6}$
	high airflow (model-generated)	upwind displacement	$\gamma 4$ (z score)	0.8198	$5.5x10^{-11}$
	high airflow (model-generated)	|heading|	$\gamma 2$ (z score)	-0.5405	0.00026
	high airflow (model-generated)	|heading|	$\gamma 3$ (z score)	0.0483	0.7644
	high airflow (model-generated)	|heading|	$\gamma 4$ (z score)	-0.1276	0.4267
	high airflow (model-generated)	forward velocity (normalized)	$\gamma 2$ (z score)	-0.6027	$3.0x10^{-5}$
	high airflow (model-generated)	forward velocity (normalized)	$\gamma 3$ (z score)	0.7369	$3.9x10^{-8}$
	high airflow (model-generated)	forward velocity (normalized)	$\gamma 4$ (z score)	0.9558	$<10^{-15}$
	high airflow (experimental)	upwind displacement	$\gamma 2$ (z score)	-0.1866	0.1854
	high airflow (experimental)	upwind displacement	$\gamma 3$ (z score)	-0.0960	0.4982
	high airflow (experimental)	upwind displacement	$\gamma 4$ (z score)	0.4354	0.0013
	high airflow (experimental)	|heading|	$\gamma 2$ (z score)	-0.1264	0.3721

	high airflow (experimental)	|heading|	γ3 (z score)	-0.1095	0.4395
	high airflow (experimental)	|heading|	γ4 (z score)	-0.2100	0.1352
	high airflow (experimental)	forward velocity (normalized)	γ2 (z score)	-0.4766	0.00035
	high airflow (experimental)	forward velocity (normalized)	γ3 (z score)	-0.2575	0.0653
	high airflow (experimental)	forward velocity (normalized)	γ4 (z score)	0.5407	$3.5x10^{-5}$
Figure 6D	low airflow – starved	|heading|	γ2 (z score)	0.2213	0.0920
	low airflow – starved	|heading|	γ3 (z score)	-0.1454	0.2720
	low airflow – starved	|heading|	γ4 (z score)	-0.4038	0.0015
	low airflow – starved	forward velocity (normalized)	γ2 (z score)	0.0897	0.4992
	low airflow – starved	forward velocity (normalized)	γ3 (z score)	-0.0158	0.9056
	low airflow – starved	forward velocity (normalized)	γ4 (z score)	0.3200	0.0135
	low airflow – fed	|heading|	γ2 (z score)	0.1218	0.3851
	low airflow – fed	|heading|	γ3 (z score)	-0.0287	0.8382
	low airflow – fed	|heading|	γ4 (z score)	-0.4878	0.0002
	low airflow – fed	forward velocity (normalized)	γ2 (z score)	-0.3341	0.0145
	low airflow – fed	forward velocity (normalized)	γ3 (z score)	-0.2219	0.1102
	low airflow – fed	forward velocity (normalized)	γ4 (z score)	-0.1562	0.2640
Extended Data Figure 3D	spontaneous movement	γ2 $\Delta F/F_o$	net motion	-0.1306	$2.1392x10^{-5}$
	spontaneous movement	γ2 $\Delta F/F_o$	forward velocity	-0.1791	$4.8059x10^{-9}$
	spontaneous movement	γ2 $\Delta F/F_o$	turning velocity	-0.0220	0.4750
	spontaneous movement	γ2 $\Delta F/F_o$	lateral velocity	0.1586	$2.2866x10^{-7}$
	spontaneous movement	γ2 $\Delta F/F_o$	time on treadmill	0.0053	0.8643
	spontaneous movement	γ2 $\Delta F/F_o$	proportion of time moving after start	0.0463	0.1331
	spontaneous movement	γ2 $\Delta F/F_o$	bout length	0.0012	0.9694
	spontaneous movement	γ2 $\Delta F/F_o$	stop length	0.0552	0.0952
	spontaneous movement	γ4 $\Delta F/F_o$	net motion	-0.0012	0.9690
	spontaneous movement	γ4 $\Delta F/F_o$	forward velocity	0.1266	$3.8097x10^{-5}$
	spontaneous movement	γ4 $\Delta F/F_o$	turning velocity	-0.07230607973	0.0189
	spontaneous movement	γ4 $\Delta F/F_o$	lateral velocity	-0.15236373	$6.7872x10^{-7}$
	spontaneous movement	γ4 $\Delta F/F_o$	time on treadmill	-0.1549	$4.3851\ x10^{-7}$
	spontaneous movement	γ4 $\Delta F/F_o$	proportion of time moving after start	0.0828	0.0072
	spontaneous movement	γ4 $\Delta F/F_o$	bout length	0.0551	0.0738
	spontaneous movement	γ4 $\Delta F/F_o$	stop length	-0.0190	0.5668

Extended Data Figure 3E	spontaneous movement	$\gamma 2\ \Delta F/F_o$	$\gamma 3\ \Delta F/F_o$	0.2411	$<10x^{-15}$
	spontaneous movement	$\gamma 2\ \Delta F/F_o$	$\gamma 4\ \Delta F/F_o$	-0.6254	$<10x^{-15}$
	spontaneous movement	$\gamma 3\ \Delta F/F_o$	$\gamma 4\ \Delta F/F_o$	-0.0178	0.5633
Extended Data Figure 4H	spontaneous movement	net motion	$\gamma 2$-$\gamma 3$	0.0305	$<10x^{-15}$
	spontaneous movement	net motion	$\gamma 2$-$\gamma 4$	0.0191	$<10x^{-15}$
	spontaneous movement	net motion	$\gamma 3$-$\gamma 4$	-0.0394	$<10x^{-15}$
	spontaneous movement	forward velocity	$\gamma 2$-$\gamma 3$	-0.0151	$<10x^{-15}$
	spontaneous movement	forward velocity	$\gamma 2$-$\gamma 4$	-0.0269	$<10x^{-15}$
	spontaneous movement	forward velocity	$\gamma 3$-$\gamma 4$	-0.0271	$<10x^{-15}$
	spontaneous movement	|angular velocity|	$\gamma 2$-$\gamma 3$	0.0155	$<10x^{-15}$
	spontaneous movement	|angular velocity|	$\gamma 2$-$\gamma 4$	0.0161	$<10x^{-15}$
	spontaneous movement	|angular velocity|	$\gamma 3$-$\gamma 4$	-0.0181	$<10x^{-15}$
Extended Data Figure 5A	low airflow	upwind displacement	$\gamma 2\ \Delta F/F_o$	-0.0589	0.4845
	low airflow	upwind displacement	$\gamma 3\ \Delta F/F_o$	0.0505	0.5494
	low airflow	upwind displacement	$\gamma 4\ \Delta F/F_o$	0.0201	0.8113
	low airflow	Δ|heading|	$\gamma 2\ \Delta F/F_o$	0.1120	0.1829
	low airflow	Δ|heading|	$\gamma 3\ \Delta F/F_o$	-0.1090	0.1950
	low airflow	Δ|heading|	$\gamma 4\ \Delta F/F_o$	-0.1730	0.0388
	low airflow	Δforward velocity	$\gamma 2\ \Delta F/F_o$	-0.0924	0.2725
	low airflow	Δforward velocity	$\gamma 3\ \Delta F/F_o$	-0.0653	0.4384
	low airflow	Δforward velocity	$\gamma 4\ \Delta F/F_o$	0.3200	$9.8x10^{-5}$
Extended Data Figure 5B	low airflow	upwind displacement	Δ|heading|	-0.6831	$<10^{-15}$
		upwind displacement	Δforward velocity	0.0139	0.8694
Extended Data Figure 5C	low airflow	net displacement	$\gamma 2\ \Delta F/F_o$	-0.1337	0.1115
	low airflow	net displacement	$\gamma 3\ \Delta F/F_o$	-0.2526	0.0023
	low airflow	net displacement	$\gamma 4\ \Delta F/F_o$	0.2322	0.0053
	low airflow	total distance	$\gamma 2\ \Delta F/F_o$	0.1441	0.0930
	low airflow	total distance	$\gamma 3\ \Delta F/F_o$	-0.0701	0.4154
	low airflow	total distance	$\gamma 4\ \Delta F/F_o$	-0.0615	0.4751
Extended Data Figure 5D	low airflow	$\gamma 2\ \Delta F/F_o$	$\gamma 4\ \Delta F/F_o$	-0.6233	$<10x^{-15}$
Extended Data Figure 5E	high airflow	upwind displacement	$\gamma 2\ \Delta F/F_o$	-0.2689	0.0539
		upwind displacement	$\gamma 3\ \Delta F/F_o$	0.0625	0.6596
		upwind displacement	$\gamma 4\ \Delta F/F_o$	0.0440	0.7566
		Δ|heading|	$\gamma 2\ \Delta F/F_o$	0.1411	0.3183
		Δ|heading|	$\gamma 3\ \Delta F/F_o$	0.0563	0.6918
		Δ|heading|	$\gamma 4\ \Delta F/F_o$	0.1212	0.3922
		Δforward velocity	$\gamma 2\ \Delta F/F_o$	-0.0481	0.7349
		Δforward velocity	$\gamma 3\ \Delta F/F_o$	-0.0934	0.5076
		Δforward velocity	$\gamma 4\ \Delta F/F_o$	0.2497	0.0742
Extended Data Figure 5F	high airflow	upwind displacement	Δ|heading|	-0.3582	0.009
		upwind displacement	Δforward velocity	0.0978	0.4903
Extended Data Figure 5H	low airflow (down-sampled)	upwind displacement	$\gamma 2\ \Delta F/F_o$	-0.2785	0.0013
	low airflow (down-sampled)	upwind displacement	$\gamma 3\ \Delta F/F_o$	0.1517	0.0849
	low airflow (down-sampled)	upwind displacement	$\gamma 4\ \Delta F/F_o$	0.4418	$1.4x10^{-7}$

	low airflow (down-sampled)	Δ|heading|	γ2 $\Delta F/F_o$	0.2218	0.01121
	low airflow (down-sampled)	Δ|heading|	γ3 $\Delta F/F_o$	0.0459	0.6044
	low airflow (down-sampled)	Δ|heading|	γ4 $\Delta F/F_o$	-0.5009	1.3×10^{-9}
	low airflow (down-sampled)	Δforward velocity	γ2 $\Delta F/F_o$	0.1654	0.0600
	low airflow (down-sampled)	Δforward velocity	γ3 $\Delta F/F_o$	0.0978	0.2685
	low airflow (down-sampled)	Δforward velocity	γ4 $\Delta F/F_o$	0.06213	0.4826
Extended Data Figure 5I	high airflow (down-sampled)	upwind displacement	γ2 $\Delta F/F_o$	-0.1573	0.2753
	high airflow (down-sampled)	upwind displacement	γ3 $\Delta F/F_o$	0.1187	0.4115
	high airflow (down-sampled)	upwind displacement	γ4 $\Delta F/F_o$	0.3685	0.0085
	high airflow (down-sampled)	Δ|heading|	γ2 $\Delta F/F_o$	-0.0843	0.5604
	high airflow (down-sampled)	Δ|heading|	γ3 $\Delta F/F_o$	0.1344	0.3521
	high airflow (down-sampled)	Δ|heading|	γ4 $\Delta F/F_o$	-0.0621	0.6683
	high airflow (down-sampled)	Δforward velocity	γ2 $\Delta F/F_o$	-0.2705	0.0574
	high airflow (down-sampled)	Δforward velocity	γ3 $\Delta F/F_o$	-0.1429	0.3221
	high airflow (down-sampled)	Δforward velocity	γ4 $\Delta F/F_o$	0.4909	0.0003
Extended Data Figure 6E	low airflow (model-generated)	upwind displacement	γ2 (z score)	0.0525	0.5336
	low airflow (model-generated)	upwind displacement	γ3 (z score)	0.1855	0.0266
	low airflow (model-generated)	upwind displacement	γ4 (z score)	0.5029	1.54×10^{-10}
	low airflow (model-generated)	|heading|	γ2 (z score)	0.0431	0.6090
	low airflow (model-generated)	|heading|	γ3 (z score)	-0.1591	0.0577
	low airflow (model-generated)	|heading|	γ4 (z score)	-0.4843	8.8×10^{-10}
	low airflow (model-generated)	forward velocity (normalized)	γ2 (z score)	0.2109	0.0115

	low airflow (model-generated)	forward velocity (normalized)	γ3 (z score)	0.5873	$1.3x10^{-14}$
	low airflow (model-generated)	forward velocity (normalized)	γ4 (z score)	0.8363	$<10^{-15}$
Extended Data Figure 6F	high airflow (model-generated)	upwind displacement	γ2 (z score)	0.6067	$2.6x10^{-5}$
	high airflow (model-generated)	upwind displacement	γ3 (z score)	0.7328	$5.1x10^{-8}$
	high airflow (model-generated)	upwind displacement	γ4 (z score)	0.2690	0.1000
	high airflow (model-generated)	|heading|	γ2 (z score)	-0.4791	0.0015
	high airflow (model-generated)	|heading|	γ3 (z score)	0.4219	0.0060
	high airflow (model-generated)	|heading|	γ4 (z score)	0.7814	$1.6x10^{-9}$
	high airflow (model-generated)	forward velocity (normalized)	γ2 (z score)	0.4797	0.0015
	high airflow (model-generated)	forward velocity (normalized)	γ3 (z score)	0.8794	$3.9x10^{-14}$
	high airflow (model-generated)	forward velocity (normalized)	γ4 (z score)	0.5274	0.0004
Extended Data Figure 9B	fed, low airflow (model-generated)	upwind displacement	γ2 (z score)	-0.2060	0.1143
	fed, low airflow (model-generated)	upwind displacement	γ3 (z score)	0.0756	0.5658
	fed, low airflow (model-generated)	upwind displacement	γ4 (z score)	0.5416	$7.9x10^{-6}$
	fed, low airflow (model-generated)	|heading|	γ2 (z score)	-0.0822	0.5323
	fed, low airflow (model-generated)	|heading|	γ3 (z score)	-0.5078	$3.5x10^{-5}$
	fed, low airflow (model-generated)	|heading|	γ4 (z score)	-0.9408	$<10^{-15}$
	fed, low airflow (model-generated)	forward velocity (normalized)	γ2 (z score)	-0.7913	$5.3x10^{-14}$
	fed, low airflow (model-generated)	forward velocity (normalized)	γ3 (z score)	-0.7416	$1.2x10^{-11}$
	fed, low airflow (model-generated)	forward velocity (normalized)	γ4 (z score)	0.0473	0.7199
Supplementary Figure 1C	spontaneous movement	γ2 $\Delta F/F_o$	PC1	-0.1421	$3.4316x10^{-6}$
	spontaneous movement	γ2 $\Delta F/F_o$	PC2	-0.0017	0.9556
	spontaneous movement	γ2 $\Delta F/F_o$	PC3	0.1013	$9.5351x10^{-4}$
	spontaneous movement	γ2 $\Delta F/F_o$	PC4	0.1939	$1.9212x10^{-10}$

Supplementary Figure 1D	spontaneous movement	γ4 $\Delta F/F_o$	PC1	-0.0542	0.0780
	spontaneous movement	γ4 $\Delta F/F_o$	PC2	0.0208	0.4994
	spontaneous movement	γ4 $\Delta F/F_o$	PC3	-0.1250	4.4914×10^{-5}
	spontaneous movement	γ4 $\Delta F/F_o$	PC4	-0.1980	7.8424×10^{-11}

Pearson Correlation Coefficient (filter swapping experiments)

Figure	filter	data set	variable 1	variable 2	slope (m)	correlation coefficient (r)	*p*-value
Extended Data Figure 6A	high airflow	low airflow	γ2 activity (predicted)	|heading|	-0.5632	-0.6902779	1.48×10^{21}
	high airflow	low airflow	γ2 activity (predicted)	forward velocity (normalized)	-0.7301	-0.3205581	9.49×10^{-05}
Extended Data Figure 6C	high airflow	low airflow	γ3 activity (predicted)	|heading|	-0.1070	-0.3852256	2.03×10^{-06}
	high airflow	low airflow	γ3 activity (predicted)	forward velocity (normalized)	-0.3251	-0.4193544	1.86×10^{-07}
Figure 5D	high airflow	low airflow	γ4 activity (predicted)	|heading|	-0.1831	-0.2480579	0.0028
	high airflow	low airflow	γ4 activity (predicted)	forward velocity (normalized)	1.609	0.7808	1.33×10^{-30}
Extended Data Figure 6B	low airflow	high airflow	γ2 activity (predicted)	|heading|	0.5119	0.8154	8.52×10^{-11}
	low airflow	high airflow	γ2 activity (predicted)	forward velocity (normalized)	0.0959	0.14284	0.3729
Extended Data Figure 6D	low airflow	high airflow	γ3 activity (predicted)	|heading|	0.0721	0.2547	0.1081
	low airflow	high airflow	γ3 activity (predicted)	forward velocity (normalized)	0.1638	0.5417	2.52×10^{-4}
Figure 5E	low airflow	high airflow	γ4 activity (predicted)	|heading|	-0.7750	-0.7014	3.25×10^{-07}
	low airflow	high airflow	γ4 activity (predicted)	forward velocity (normalized)	0.8961	0.7588	9.01×10^{-09}
Extended Data Figure 9C	fed	starved	γ2 activity (predicted)	|heading|	-0.0111	-0.0284	0.7360
	fed	starved	γ2 activity (predicted)	forward velocity (normalized)	-0.7563	-0.6910	1.28×10^{-21}
Extended Data Figure 9E	fed	starved	γ3 activity (predicted)	|heading|	-0.1186	-0.3779	3.26×10^{-06}
	fed	starved	γ3 activity (predicted)	forward velocity (normalized)	-0.6395	-0.7302	4.32×10^{-25}
Extended Data Figure 9G	fed	starved	γ4 activity (predicted)	|heading|	-0.5179	-0.8722	1.23×10^{-45}
	fed	starved	γ4 activity (predicted)	forward velocity (normalized)	-0.0088	-0.0053	0.9497
Extended Data Figure 9D	fed	starved	γ2 activity (predicted)	|heading|	0.5212	0.9694	4.52×10^{-37}
	fed	starved	γ2 activity (predicted)	forward velocity (normalized)	0.0784	0.0431	0.7439
Extended Data Figure 9F	fed	starved	γ3 activity (predicted)	|heading|	0.1451	0.8462	1.70×10^{-17}
	fed	starved	γ3 activity (predicted)	forward velocity (normalized)	0.1492	0.2570	0.0475

Extended Data Figure 9H	fed	starved	γ4 activity (predicted)	|heading|	-0.6083	-0.9366	4.32×10^{-28}
	fed	starved	γ4 activity (predicted)	forward velocity (normalized)	0.8330	0.3788	0.0028

Fisher r-to-z transformation (within contexts)

Figure	correlation 1	correlation 1	z-score	p-value
Figure 3C	upwind displacement - Δforward velocity	upwind displacement - Δ|heading|	-8.38	<0.00001
Figure 3F	upwind displacement - γ2	Δforward velocity - γ2	-4.34	<0.00001
	upwind displacement - γ2	Δ|heading| - γ2	-6.08	<0.00001
	Δforward velocity - γ2	Δ|heading| - γ2	1.74	0.0409
	upwind displacement - γ3	Δforward velocity - γ3	-2.94	0.0016
	upwind displacement - γ3	Δ|heading| - γ3	-2.99	0.0014
	Δforward velocity - γ3	Δ|heading| - γ3	-0.06	0.4761
	upwind displacement - γ4	Δforward velocity - γ4	3.8	0.0001
	upwind displacement - γ4	Δ|heading| - γ4	9.84	<0.00001
	Δforward velocity - γ4	Δ|heading| - γ4	-6.03	<0.00001
Figure 4B	upwind displacement - Δforward velocity	upwind displacement - Δ|heading|	-7.43	<0.00001
Figure 4D	upwind displacement - γ2	Δforward velocity - γ2	0.64	0.2611
	upwind displacement - γ2	Δ|heading| - γ2	-1.51	0.0655
	Δforward velocity - γ2	Δ|heading| - γ2	-2.15	0.0158
	upwind displacement - γ3	Δforward velocity - γ3	0.05	0.4801
	upwind displacement - γ3	Δ|heading| - γ3	-0.99	0.1611
	Δforward velocity - γ3	Δ|heading| - γ3	-1.04	0.1492
	upwind displacement - γ4	Δforward velocity - γ4	-0.91	0.1814
	upwind displacement - γ4	Δ|heading| - γ4	3.55	0.0002
	Δforward velocity - γ4	Δ|heading| - γ4	4.46	<0.00001

Fisher r-to-z transformation (across contexts)

Figure	variable 1	variable 2	context	z-score	p-value
Figures 3C vs 4B	upwind displacement	Δ(forward velocity)	low vs high	-3.89	0.0001
	upwind displacement	Δ(|heading|)	low vs high	-0.04	0.484
Figures 3F vs 4D	upwind displacement	γ2 $\Delta F/F_o$	low vs high	-0.57	0.2843
	upwind displacement	γ3 $\Delta F/F_o$	low vs high	-0.49	0.3121
	upwind displacement	γ4 $\Delta F/F_o$	low vs high	0.21	0.4168
	Δ(|heading|)	γ2 $\Delta F/F_o$	low vs high	1.51	0.0655
	Δ(|heading|)	γ3 $\Delta F/F_o$	low vs high	0.23	0.409
	Δ(|heading|)	γ4 $\Delta F/F_o$	low vs high	-1.77	0.0384
	Δ(forward velocity)	γ2 $\Delta F/F_o$	low vs high	3.07	0.0011
	Δ(forward velocity)	γ3 $\Delta F/F_o$	low vs high	1.5	0.0668
	Δ(forward velocity)	γ4 $\Delta F/F_o$	low vs high	-3.42	0.0003
Figure 6D	|heading|	γ2 (z score)	starved vs fed	0.5	0.3085
	|heading|	γ3 (z score)	starved vs fed	-0.58	0.281
	|heading|	γ4 (z score)	starved vs fed	0.51	0.305
	forward velocity (normalized)	γ2 (z score)	starved vs fed	2.14	0.0162
	forward velocity (normalized)	γ3 (z score)	starved vs fed	1.03	0.1515
	forward velocity (normalized)	γ4 (z score)	starved vs fed	2.39	0.0084

Fisher r-to-z transformation (across contexts)

Figure	variable 1	variable 2	context	z-score	p-value
Figures 5B	upwind displacement	γ2 (z score)	model vs experimental (low airflow)	-4.81	<0.00001
	upwind displacement	γ3 (z score)		-2.66	0.0039
	upwind displacement	γ4 (z score)		6.41	<0.00001
	|heading|	γ2 (z score)		9.05	<0.00001
	|heading|	γ3 (z score)		5.07	<0.00001
	|heading|	γ4 (z score)		-6.51	<0.00001
	forward velocity (normalized)	γ2 (z score)		-1.09	0.1379

	forward velocity (normalized)	γ3 (z score)		1.92	0.0274
	forward velocity (normalized)	γ4 (z score)		3.2	0.0007
Figures 5C	upwind displacement	γ2 (z score)	model vs experimental (high airflow)	-0.28	0.3897
	upwind displacement	γ3 (z score)		-3.06	0.0011
	upwind displacement	γ4 (z score)		3.01	0.0013
	|heading|	γ2 (z score)		-2.08	0.0188
	|heading|	γ3 (z score)		0.69	0.2451
	|heading|	γ4 (z score)		0.37	0.3557
	forward velocity (normalized)	γ2 (z score)		-0.78	0.2177
	forward velocity (normalized)	γ3 (z score)		5.26	<0.00001
	forward velocity (normalized)	γ4 (z score)		5.62	<0.00001
Extended Data Figure 6A vs 6B	|heading|	γ2 (z score)	swapped filters	-16.66	<0.00001
	forward velocity (normalized)	γ2 (z score)		-3.98	<0.00001
Extended Data Figure 6C vs 6D	|heading|	γ3 (z score)		-5.58	<0.00001
	forward velocity (normalized)	γ3 (z score)		-8.81	<0.00001
Figures 5D vs 5E	|heading|	γ4 (z score)		5.16	<0.00001
	forward velocity (normalized)	γ4 (z score)		0.45	0.3264
Figure 6D vs Extended Data Figure 9B	|heading|	γ2 (z score)	model vs experimental (fed, low airflow)	0.4	0.3446
	|heading|	γ3 (z score)		0.66	0.2546
	|heading|	γ4 (z score)		-0.02	0.492
	forward velocity (normalized)	γ2 (z score)		-2.81	0.0025
	forward velocity (normalized)	γ3 (z score)		-4.5	<0.00001
	forward velocity (normalized)	γ4 (z score)		-6.83	<0.00001
Extended Data Figure 9C vs 9D	|heading|	γ2 (z score)	swapped filters	-10.55	<0.00001
	forward velocity (normalized)	γ2 (z score)		-4.46	<0.00001
Extended Data Figure 9E vs 9F	|heading|	γ3 (z score)		-12.4	<0.00001
	forward velocity (normalized)	γ3 (z score)		-4.86	<0.00001
Extended Data Figure 9G vs 9H	|heading|	γ4 (z score)		1.84	0.0329
	forward velocity (normalized)	γ4 (z score)		-2.02	0.0217

Nested Linear Model

Figure	DAN	context	odor	factors	residual variance	*F*-statistic	*p*-value
Extended Data Figure 8B	γ2	low airflow	+ odor (ACV)	none	0.0403787	NaN	NaN
				h_o	0.03760409	6.34548863	0.01361784
				$\Delta V_{1\text{-}4}$	0.0351768	5.86522439	0.01756883
				$\Delta h_{1\text{-}4}$	0.0346849	1.19128277	0.27819172
				$\Delta h_{4\text{-}7}$	0.03079687	10.4785484	0.00173631
	γ2	low airflow	- odor (air)	none	0.02869513	NaN	NaN
				h_o	0.02868193	0.04004464	0.84186034
				$\Delta V_{1\text{-}4}$	0.02864149	0.12142365	0.72834712
				$\Delta h_{1\text{-}4}$	0.02791286	2.21881958	0.14003855
				$\Delta h_{4\text{-}7}$	0.02789138	0.06469075	0.7998516
	γ3	low airflow	+ odor (ACV)	none	0.01925491	NaN	NaN
				h_o	0.01877697	2.18899949	0.14265348
				$\Delta V_{1\text{-}4}$	0.01877463	0.01056944	0.91835769
				$\Delta h_{1\text{-}4}$	0.0187071	0.303232	0.58332487
				$\Delta h_{4\text{-}7}$	0.0165204	10.986201	0.00136227
	γ3	low airflow	- odor (air)	none	0.02476782	NaN	NaN
				h_o	0.02475873	0.03194851	0.85855629
				$\Delta V_{1\text{-}4}$	0.02365998	3.99375853	0.04882803

				Δh_{1-4}	0.02298707	2.48827356	0.1184121
				Δh_{4-7}	0.02289354	0.3431666	0.55957776
	γ4	low airflow	+ odor (ACV)	none	0.09468233	NaN	NaN
				h_o	0.09169558	2.801236	0.0104504
				ΔV_{1-4}	0.08485019	6.85747434	0.0104504
				Δh_{1-4}	0.07185056	15.1977827	0.0001941
				Δh_{4-7}	0.06623637	7.03506999	0.00957401
	γ4	low airflow	- odor (air)	none	0.03801041	NaN	NaN
				h_o	0.03719132	1.91606339	0.16983177
				ΔV_{1-4}	0.03419821	7.52692833	0.00739658
				Δh_{1-4}	0.03419806	0.0003621	0.98486264
				Δh_{4-7}	0.0341292	0.16947248	0.6816296
Extended Data Figure 8C	γ2	high airflow	+ odor (ACV)	none	0.0541142	NaN	NaN
				h_o	0.05392805	0.1311693	0.71922917
				ΔV_{1-4}	0.03265512	24.1033708	1.87×10^{-5}
				Δh_{1-4}	0.03240844	0.2740167	0.60385762
				Δh_{4-7}	0.0323156	0.10054644	0.75305869
	γ2	high airflow	- odor (air)	none	0.02734259	NaN	NaN
				h_o	0.02332821	6.36705479	0.01605225
				ΔV_{1-4}	0.02318236	0.22649725	0.63700885
				Δh_{1-4}	0.02271852	0.71458193	0.40366891
				Δh_{4-7}	0.0227161	0.00362774	0.9523245
	γ3	high airflow	+ odor (ACV)	none	0.02061051	NaN	NaN
				h_o	0.01906929	3.07124704	0.08775449
				ΔV_{1-4}	0.01906849	0.00155187	0.96878828
				Δh_{1-4}	0.01881729	0.48057828	0.49260912
				Δh_{4-7}	0.01869893	0.22153756	0.64079109
	γ3	high airflow	- odor (air)	none	0.01536549	NaN	NaN
				h_o	0.01513746	0.55735452	0.46004583
				ΔV_{1-4}	0.01433653	2.0111824	0.16474248
				Δh_{1-4}	0.01430721	0.07173626	0.79039754
				Δh_{4-7}	0.01361378	1.73182213	0.19698253
	γ4	high airflow	+ odor (ACV)	none	0.15558791	NaN	NaN
				h_o	0.14598583	2.49941493	0.1221775
				ΔV_{1-4}	0.07066354	39.4393612	2.62×10^{-7}
				Δh_{1-4}	0.0669172	2.01544606	0.16430746
				Δh_{4-7}	0.06381549	1.701153	0.20064965
	γ4	high4airflow	- odor (air)	none	0.03775205	NaN	NaN
				h_o	0.03624028	1.54346557	0.22191945
				ΔV_{1-4}	0.03281815	3.75392147	0.06055977
				Δh_{1-4}	0.03277167	0.04963495	0.8249948
				Δh_{4-7}	0.03229766	0.49899509	0.48475498

Paired *t*-test

Figure	**variable**	**context 1**	**context 2**	**condition**	***p*-value**
Figure 6B	upwind displacement	starved	fed	+ odor (ACV)	0.0051
	|heading|	starved	fed	+ odor (ACV)	0.0062
	forward velocity	starved	fed	+ odor (ACV)	0.0062
Figure 6C	γ2 $\Delta F/F_o$	starved	fed	+ odor (ACV)	0.0012
	γ3 $\Delta F/F_o$	starved	fed	+ odor (ACV)	0.1309
	γ4 $\Delta F/F_o$	starved	fed	+ odor (ACV)	0.0045
Extended Data Figure 1B	γ2 DAN activity	movement	sucrose ingestion	- odor (ACV)	2.6633×10^{-8}
	γ3 DAN activity	movement	sucrose ingestion	- odor (ACV)	1.6860×10^{-6}
	γ4 DAN activity	movement	sucrose ingestion	- odor (ACV)	3.0386×10^{-7}
	γ5 DAN activity	movement	sucrose ingestion	- odor (ACV)	2.3978×10^{-7}
Extended Data Figure 1B	γ2 dLight activity	movement	sucrose ingestion	- odor (ACV)	2.2463×10^{-4}
	γ3 dLight activity	movement	sucrose ingestion	- odor (ACV)	0.0038
	γ4 dLight activity	movement	sucrose ingestion	- odor (ACV)	0.0085
	γ5 dLight activity	movement	sucrose ingestion	- odor (ACV)	2.6509×10^{-5}
Supplementary Figure 3D	upwind displacement	+ odor (ACV)	- odor (air)	low airflow	0.2646
Supplementary Figure 3D	upwind displacement	+ odor (ACV)	- odor (air)	high airflow	.3567

Supplementary Figure 30E	upwind displacement	starved	fed	- odor (air)	0.0248
Supplementary Figure 3E	|heading|	starved	fed	- odor (air)	0.3878
Supplementary Figure 3E	forward velocity	starved	fed	- odor (air)	0.0031

Paired *t*-test: freely moving flies

Figure	variable	context 1	context 2	condition	genotype	*p*-value
Figure 7C	upwind displacement	+ light	- light	+ odor (ACV)	PAM DANs (MB042B driver)>GtACR1	1.0982×10^{-13}
	upwind displacement	+ light	- light	+ odor (ACV)	PAM DANs (MB196B driver)>GtACR1	1.3864×10^{-7}
	upwind displacement	+ light	- light	+ odor (ACV)	PPL DANs (MB504B driver)>GtACR1	0.7843
	upwind displacement	+ light	- light	+ odor (ACV)	γ4 DANs (MB312B driver)>GtACR1	1.9723×10^{-5}
	upwind displacement	+ light	- light	+ odor (ACV)	PAM DANs MB042B-Gal4	0.7582
	upwind displacement	+ light	- light	+ odor (ACV)	UAS-GtACR1	0.6725
Figure 7D	upwind displacement	+ light	- light	+ odor (ACV)	PAM DANs (MB042B driver)>CsChrimson	4.4321×10^{-6}
	upwind displacement	+ light	- light	+ odor (ACV)	UAS-CsChrimson	0.6258
	upwind displacement	+ light	- light	- odor (air)	PAM DANs (MB042B driver)>CsChrimson	3.7168×10^{-6}
	upwind displacement	+ light	- light	- odor (air)	UAS-CsChrimson	0.0637
Extended Data Figure 10A	upwind speed	+ light	- light	+ odor (ACV)	PAM DANs (MB042B driver)>GtACR1	1.6375×10^{-15}
	upwind speed	+ light	- light	+ odor (ACV)	PAM DANs (MB196B driver)>GtACR1	4.2441×10^{-9}
	upwind speed	+ light	- light	+ odor (ACV)	PPL DANs (MB504B driver)>GtACR1	0.1123
	upwind speed	+ light	- light	+ odor (ACV)	γ4 DANs (MB312B driver)>GtACR1	2.6248×10^{-10}
	upwind speed	+ light	- light	+ odor (ACV)	PAM DANs MB042B-Gal4	0.0667
	upwind speed	+ light	- light	+ odor (ACV)	UAS-GtACR1	0.0047
Extended Data Figure 10B	upwind speed	+ light	- light	+ odor (ACV)	PAM DANs (MB042B driver)>CsChrimson	0.1789
	upwind speed	+ light	- light	+ odor (ACV)	UAS-CsChrimson	0.1087
	upwind speed	+ light	- light	- odor (air)	PAM DANs (MB042B driver)>CsChrimson	3.6551×10^{-6}
	upwind speed	+ light	- light	- odor (air)	UAS-CsChrimson	0.0461

Unpaired *t*-test: freely moving flies

Figure	variable	context 1	context 2	condition	*p*-value
Supplementary Figure 2F	upwind displacement	starved	fed	+ odor (ACV)	8.0850×10^{-7}
	proportion walking upwind	starved	fed	+ odor (ACV)	2.2979×10^{-10}
	upwind speed	starved	fed	+ odor (ACV)	2.1660×10^{-5}

Two-sample F-test for equal variances

Figure	dataset 1	dataset 1	context	*p*-value
Extended Data Figure 5H	upwind displacement (low airflow, downsampled)	upwind displacement (high airflow)	+ odor (ACV)	0.1787

	|heading| (low airflow, downsampled)	∆|heading| (high airflow)	+ odor (ACV)	0.0876
	forward velocity (low airflow, downsampled)	∆forward velocity (high airflow)	+ odor (ACV)	0.0053
Extended Data Figure 5I	upwind displacement (high airflow, downsampled)	upwind displacement (low airflow)	+ odor (ACV)	0.3654
	|heading| (high airflow, downsampled)	∆|heading| (low airflow)	+ odor (ACV)	8.3×10^{-4}
	forward velocity (high airflow, downsampled)	∆forward velocity (low airflow)	+ odor (ACV)	0.053
Supplementary Figure 3A	|heading| in odor	|heading| in air	low airflow	0.1318
Supplementary Figure 3A	forward velocity in odor	forward velocity in air	low airflow	0.0508
Supplementary Figure 3B	|heading| in odor	|heading| in air	high airflow	0.0991
Supplementary Figure 3B	forward velocity in odor	forward velocity in air	high airflow	0.0764
Supplementary Figure 3C	|heading| (low airflow)	|heading| (high airflow)	+ odor (ACV)	8.1881×10^{-195}
Supplementary Figure 3C	forward velocity (low airflow)	forward velocity (high airflow)	+ odor (ACV)	2.3662×10^{-89}