Supplemental Data

Coding of Odors by a Receptor Repertoire

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Supplemental Experimental Procedures

In Figure 4, the receptors are listed along the y-axis in the following order, beginning at the origin: (A) Or2a, Or47b, Or33b, Or49b, Or65a, Or23a, Or85f, Or88a, Or67c, Or43a, Or7a, Or43b, Or59b, Or9a, Or85a, Or47a, Or22a, Or19a, Or67a, Or35a, Or98a, Or85b, Or82a, and Or10a; (B) Or2a, Or47b, Or33b, Or88a, Or49b, Or65a, Or23a, Or85f, Or82a, Or43a, Or9a, Or19a, Or43b, Or10a, Or67c, Or85a, Or98a, Or47a, Or67a, Or59b, Or35a, Or22a, Or85b, Or7a.

In Figure 5, receptors are listed in the following orders along the y-axes, beginning at the origin: methyl salicylate = Or88a, Or65a, Or33b, Or47a, Or59b, Or22a, Or67c, Or82a, Or85a, Or23a, Or85f, Or47b, Or2a, Or43b, Or85b, Or35a, Or9a, Or7a, Or98a, Or67a, Or43a, Or49b, Or19a, Or10a; pentyl acetate = Or 47b, Or33b, Or88a, Or10a, Or7a, Or49b, Or67c, Or23a, Or82a, Or85a, Or85f, Or2a, Or65a, Or43a, Or59b, Or43b, Or9a, Or22a, Or19a, Or35a, Or67a, Or85b, Or98a, Or47a; 2-heptanone = Or47b, Or33b, Or7a, Or88a, Or49b, Or10a, Or59b, Or23a, Or85a, Or67c, Or65a, Or85f, Or82a, Or2a, Or43b, Or43a, Or9a, Or22a, Or35a, Or67a, Or19a, Or98a, Or85b, Or47a; apple = Or47b, Or88a, Or49b, Or33b, Or85f, Or2a, Or65a, Or43a, Or67c, Or23a, Or19a, Or9a, Or59b, Or82a, Or85a, Or43b, Or10a, Or98a, Or47a, Or22a, Or67a, Or35a, Or7a, Or85b.

Supplemental Table Legends

Table S1. Odorant Responses of 24 Receptors to 110 Odorants
Odorants are color-coded by functional group as in Figure 1. Spontaneous firing rates for each receptor are indicated at the bottom of the table. Data for the set of odorants tested across concentrations are from Figure 4 and n = 6; for all other odorants, n = 6 except that n = 4 for responses of <50 spikes/s.

Table S2. Odor Responses for Selected Odorants and Fruit Odors across Concentrations
n = 6.

Tables S3 and S4. Responses of the Antennal Receptors to Selected Odorants as a Function of Time
Data are those of Figure 5.

Supplemental Figure Legends

Figure S1. An In Vivo Expression System for the Functional Analysis of Odorant Receptors

(A) A mutant ab3A antennal neuron (the "empty neuron," designated as Δab3A) lacks odor response due to the deletion of its endogenous odorant receptor genes, *Or22a* and *Or22b*. Individual odorant receptors are expressed specifically in the Δab3A neuron (Δab3A:OrX) by using an *Or22a-GAL4* construct to drive expression from a *UAS-Or* construct. The odor response of the Δab3A:OrX neuron is assayed electrophysiologically. Adapted from (Hallem et al., 2004b).

(B) Examples of extracellular single-unit recordings from Δab3A neurons. The Δab3A neuron alone lacks odor response (*w*; Δ*halo*; top trace, large spikes). The response of the ab3B neuron, which is in the same sensillum, is also visible (small spikes). Expression of Or82a in Δab3A (Δab3A:Or82a) confers a response to geranyl acetate (lower traces, *w*; Δ*halo; Or22a-GAL4/UAS-Or82a*). Odorant was delivered as a 10^{-2} dilution of geranyl acetate in paraffin oil.

Figure S2. Odorant Responses of 24 Receptors to 110 Odorants

Response magnitudes are color-coded according to the scale shown at the right. The order of odorants is that shown in Figure 6, and the order of receptors is based on hierarchical clustering using their distances in an 110-dimensional space constructed from the response of each of the 24 antennal receptors to each of the 110 odorants.

Figure S3. Ligand Specificities for Or49b (A) and Or10a (B)

Hydrogen atoms are indicated in white and oxygen atoms are indicated in red.

Figure S4. Receptor Responses to Odor Pulses of Different Durations (100 ms, 500 ms, 1 s, or 5 s)

Responses were quantified in 500 ms bins, with the exception that for the responses to 100 ms pulses, the first two bins spanned 100 ms and 400 ms, respectively. The number of spikes in an equivalent interval of unstimulated activity was subtracted from each bin. n=6. The horizontal black lines at the top of each panel represent the odor stimuli. Error bars = SEM.

Figure S5. Relationship between Glomerular Distance and Receptor Similarity

Receptor similarity was determined as the Euclidean distance between receptors in the 110-dimensional space constructed from the response of each of the 24 antennal receptors to each of the 110 odorants.

(A) Data for all receptors, with the exception of Or33b, Or2a, Or67c, and Or85b (see Figure 8 legend). $r = 0.15$; $p = 0.18$, two-tailed (Mantel test).

(B) Data for the subset of receptors that responded strongly (≥100 spikes/s) to at least one odorant. $r = -0.008$; $p = 0.59$, two-tailed (Mantel test).

Figure S6. Mapping Receptor Responses to Alcohols (A) and Esters (B) of Varying Chain Lengths onto Glomeruli in the AL

Each glomerulus is color-coded based on the magnitude of the response of the receptor expressed in its presynaptic ORN population. For each odor, the AL is shown from two different perspectives, as indicated at the bottom of each column. In the perspective on the left of each panel, posterior is below the plane of the page; in the right perspective, all three axes point up from the page. Glomeruli are color-coded using a normalized color gradient (lower left); strongest response=red, weakest response=blue. Glomerular identifications are as in Figure 8.

Figure S7. Odor Space as Visualized by PCA after the Removal of Randomly Chosen Subsets of Five Receptors from the Data Set

(A) The view of odor space obtained using the entire data set.

(B-E) The views of odor space obtained from four different test trials. For each test, five randomly chosen receptors were removed from the data set. The following receptors were removed from the analysis: (B) Trial 1: Or9a, Or10a, Or23a, Or35a, Or82a; (C) Trial 2: Or33b, Or35a, Or82a, Or85a, Or98a; (D) Trial 3: Or9a, Or19a, Or23a, Or35a, Or82a; (E) Trial 4: Or10a, Or35a, Or43a, Or67a, Or85b.

	2a	7a	9a	10a	19a	22a	23a	33b	35a	43a	43b	47a	47b	49b	59b	65a	67a	67c	82a	85a	85b	85f	88a	98a
ammonium hydroxide	3	-21	32	10	1	13	-2	-9	4	-1	3	16	-8	4	5	3	16	10	2	-6	15	17	0	24
putrescine	6	-36	26	-26	-9	12	-2	-4	0	-17	1	-9	-25	-7	2	-2	-4	6	-4	-13	24	8	-6	17
cadaverine	1	-41	21	-17	-5	13	-7	-7	12	-10	12	-8	-16	-2	7	-1	-8	14	-2	-11	29	16	0	21
g-butyrolactone	9	34	53	-6	-7	43	4	7	81	-12	19	6	9	-1	16	6	125	20	-7	-8	47	23	2	29
g-hexalactone	15	-39	118	18	-2	140	12	25	171	8	30	24	-36	-1	18	18	47	40	5	-3	53	54	3	24
g-octalactone	7	-22	26	18	2	41	3	10	36	-5	27	17	-19	-3	0	20	25	16	20	-13	174	31	-16	101
g-decalactone	-1	-12	-1	-2	-22	16	-3	17	-3	-18	2	-3	-3	0	-4	-2	7	1	-8	-11	13	-5	7	9
d-decalactone	0	-15	-2	-11	-23	11	-2	15	-10	-16	2	0	-4	-4	2	-5	2	0	-5	1	24	-1	-1	8
methanoic acid	-2	-14	14	31	0	33	-8	-6	5	-9	8	-1	-20	3	25	2	5	12	-8	-9	14	7	0	4
acetic acid	5	-11	9	18	3	32	-1	-2	-1	0	10	2	-21	5	24	4	-5	6	10	1	27	11	-5	19
propionic acid	1	5	20	36	5	37	-3	-9	2	-5	7	7	-22	9	24	8	49	18	7	-6	41	15	-7	11
butyric acid	11	42	138	33	10	117	-3	-11	12	-7	20	17	-27	8	34	9	132	16	7	-10	39	21	-2	11
pentanoic acid	7	22	19	22	30	45	2	-11	36	-5	7	14	-22	2	24	2	207	11	25	-3	30	11	-7	-9
hexanoic acid	8	3	22	19	30	117	7	22	7	5	7	9	-24	7	29	7	20	12	19	-11	40	21	-5	13
heptanoic acid	3	-6	3	-1	-19	12	-2	-4	11	-11	20	1	-7	-4	16	-1	1	-3	-5	1	37	5	-3	-2
octanoic acid	-2	-7	-2	-1	-26	0	2	-13	-4	-5	10	5	-11	-1	5	-1	-9	2	-7	-5	68	7	1	-5
nonanoic acid	-2	-10	-6	2	-19	7	-4	-2	-8	-15	6	-4	-4	0	7	-6	-4	5	-7	1	43	5	-3	-8
linoleic acid	-7	136	3	4	-30	3	5	-11	38	-14	34	22	-20	-1	9	8	-1	-4	-7	2	58	7	-9	-5
isobutyric acid	-2	8	19	29	7	34	-3	-9	1	-5	10	14	-19	4	30	2	-1	13	11	-7	35	14	-4	10
isopentanoic acid	4	-4	23	24	21	41	-4	-10	5	-12	9	11	-15	6	28	3	46	15	24	1	20	14	-3	5
pyruvic acid	3	55	22	23	-1	35	-1	-12	5	-1	9	16	-20	1	20	8	5	11	-8	-9	23	10	3	1
2-ethylhexanoic acid	3	1	4	5	-22	19	-2	-15	-8	-25	45	21	-16	-1	21	3	-4	8	-6	-1	99	16	-12	4
lactic acid	2	-2	6	34	-4	36	-3	-3	9	1	6	14	-21	4	16	2	3	21	-5	-11	15	10	-3	13
3-methylthio-1-propanol	8	29	96	5	-9	38	-2	-7	188	4	37	200	-26	-1	31	-2	51	46	30	25	46	42	2	28
dimethyl sulfide	0	-8	19	-16	-27	13	-4	-6	-2	-19	11	-2	-8	-10	64	-6	1	2	2	-8	32	21	-6	-11
terpinolene	-6	6	-1	-7	51	19	-3	10	7	-6	12	8	-6	2	12	-4	34	15	-5	-6	36	5	6	81
a-pinene	-2	20	-1	-2	21	33	-3	13	28	6	4	18	-8	-4	0	1	7	14	-3	-1	48	18	2	30
b-pinene	3	-11	-6	-12	40	10	-4	10	3	10	9	-4	2	1	-4	-6	-6	6	-2	3	34	1	2	-3
(1S)-(+)-3-carene	-1	4	1	-12	123	11	-5	5	-4	9	7	5	-2	-6	-4	-3	2	11	-5	8	16	4	4	-7
limonene	3	4	3	-5	92	34	-4	8	51	-6	6	25	-5	5	-5	-3	2	11	2	3	47	1	2	30
a-humulene	-1	10	-2	-9	-7	9	-3	-1	3	-11	5	6	0	6	-1	-2	1	10	-8	-4	19	-4	6	-2
b-myrcene	2	9	-1	-9	21	19	-4	4	0	-5	7	-2	-1	-3	-5	-1	37	12	-7	3	21	2	7	20
(-)-trans-caryophyllene	2	4	3	-6	21	8	-5	14	14	-25	8	5	-6	-7	12	-1	-6	8	-1	1	34	5	0	-4
p-cymene	-2	-1	-2	-8	20	18	-6	3	9	-8	2	12	-2	3	-1	-8	-2	8	-12	-1	17	4	5	-9
geranyl acetate	2	1	-5	-8	9	1	4	0	-3	-10	10	-2	-1	-4	37	-7	7	-3	241	-1	-2	-2	1	81
a-terpineol	2	5	7	-10	85	63	-4	10	18	1	6	12	-8	-3	-8	4	19	18	3	-12	51	-2	7	11
geraniol	-1	1	-1	-6	2	28	-6	15	9	-16	6	1	-7	-2	1	-2	49	23	29	-4	41	1	7	89
nerol	8	10	2	-12	22	37	-3	13	10	-7	9	0	-7	7	-8	5	14	13	1	-2	42	5	7	65
linalool	17	31	6	-14	125	52	3	29	26	-6	1	20	-14	-8	-8	2	84	7	12	-16	51	4	-2	140
b-citronellol	3	21	6	-10	18	25	-6	8	11	-13	7	-1	-6	-5	-2	-1	6	19	5	8	41	-5	7	50
linalool oxide	30	-14	79	1	91	25	8	17	-5	18	14	25	-9	-12	18	3	35	22	27	9	33	44	4	36
acetaldehyde	21	165	95	25	19	71	11	11	4	4	8	55	-38	-1	62	13	12	47	10	35	37	24	5	18
propanal	18	-16	6	-1	-52	36	-5	3	-6	-31	15	12	-40	-8	12	-7	5	15	-15	15	52	8	-9	11
butanal	43	54	6	-2	-38	53	-6	0	65	-11	51	20	-26	-7	9	-4	62	21	7	5	53	18	-3	26
pentanal	22	171	24	6	-20	69	-5	3	82	-13	12	28	-22	-8	11	1	45	20	10	-2	54	26	-2	27
hexanal	19	177	34	28	-29	139	13	-10	185	-4	44	46	-21	-4	17	13	29	15	8	20	224	43	-9	29
E2-hexenal	17	221	38	-8	58	49	45	-8	227	41	84	37	18	6	3	-2	117	47	-6	11	145	35	-8	28
furfural	11	176	93	34	-22	29	18	28	176	-17	34	6	-19	-4	50	-1	182	36	39	-2	61	59	-12	33
2-propenal	14	31	3	-7	-12	32	-6	6	-9	-7	11	8	-16	-3	19	2	21	5	-5	19	36	2	4	22
acetone	1	-10	29	0	-25	38	-7	-10	8	-16	11	3	-6	-3	130	-7	27	-5	-4	-5	28	18	-9	-1
2-butanone	8	9	94	7	-16	84	3	7	13	-8	25	16	-15	3	144	-2	67	21	17	1	39	41	-14	4
2-pentanone	30	2	130	19	-1	148	13	10	112	12	75	74	-31	3	60	12	70	60	32	-8	115	52	-19	11
2-heptanone	39	-2	106	17	131	111	25	0	119	42	71	209	-10	21	25	35	170	36	32	33	190	40	19	189
6-methyl-5-hepten-2-one	46	-24	58	8	69	85	28	-11	-12	7	46	40	6	-5	0	49	234	16	61	-7	257	34	-15	232
2,3-butanedione	3	13	60	22	35	48	15	11	13	11	69	25	7	6	97	8	84	42	20	40	71	14	11	34
phenethyl alcohol	2	3	17	-16	14	46	-2	29	120	28	6	9	-20	45	2	-6	236	67	25	3	20	8	4	-8
benzyl alcohol	-4	5	30	-5	-9	40	-5	34	44	52	0	8	-21	111	14	-3	116	26	23	-4	19	25	1	1
methyl salicylate	5	-6	13	258	1	-2	-1	-7	2	20	12	-6	6	48	-4	-13	35	-2	-5	2	-8	5	-7	8
methyl benzoate	1	-27	43	265	-12	43	-6	-12	-14	-3	32	38	-4	19	-2	-6	208	10	31	4	29	46	-9	226
ethyl benzoate	1	-20	29	268	-6	49	-6	-3	-16	-26	6	27	-11	-6	-5	-6	198	-4	-4	-14	14	21	-5	273
phenethyl acetate	11	-13	18	-12	7	40	-4	0	-13	-12	2	24	-15	7	34	17	185	1	19	-8	28	7	-4	24
benzaldehyde	5	200	57	123	-15	32	-5	-5	83	36	12	22	-18	101	6	-10	200	6	-10	7	37	49	-3	30
phenylacetaldehyde	10	43	14	64	-30	32	1	7	-17	-6	8	27	-17	79	7	3	153	17	9	10	39	20	0	27
acetophenone	-3	10	62	254	5	32	-6	-16	10	37	10	38	-6	79	5	12	184	35	-16	-25	22	84	-12	29
ethyl cinnamate	-4	-6	-2	-7	-21	12	-1	3	-10	-19	2	-1	-1	3	-2	2	75	-1	-1	-7	35	-11	4	7
2-methylphenol	-11	-27	36	-17	-16	9	-8	-16	-12	77	35	-11	-27	250	-7	-18	57	2	-14	-14	27	31	-14	-21
4-ethyl guaiacol	-1	-10	14	2	-10	7	-9	-3	-3	-5	3	-2	-5	-2	6	-8	4	31	-7	-6	39	14	-1	1
eugenol	4	-10	10	64	-16	7	1	-6	-7	-14	10	0	-4	-6	21	-7	7	-3	-1	-4	34	12	-3	50
methanol	10	22	25	5	-16	55	-3	35	38	-2	14	13	-21	9	18	3	3	20	3	14	17	6	-8	5
ethanol	4	33	21	12	-12	55	6	36	34	-7	13	9	-22	1	13	2	4	26	16	17	27	2	-12	3
1-propanol	33	180	52	-4	10	58	5	27	55	-13	33	16	-18	1	12	-5	16	48	17	0	47	22	-6	-9
1-butanol	45	195	103	-5	49	120	41	39	199	-1	73	24	-25	26	44	-2	65	72	38	2	44	28	0	-7
1-pentanol	35	166	160	11	84	179	73	42	188	77	109	62	-31	44	55	1	148	126	55	47	169	56	8	75
1-hexanol	40	96	102	10	146	63	51	1	237	133	73	58	-35	31	35	7	173	109	58	137	183	64	16	158
1-octanol	1	-18	20	-18	92	53	1	3	222	-13	28	7	-32	-6	-7	-4	44	11	35	4	56	10	-20	24
2-pentanol	38	78	227	17	74	113	41	45	162	96	168	77	-33	32	39	8	33	98	60	45	144	58	5	81
3-methylbutanol	30	157	97	-6	78	104	33	33	222	54	49	24	-33	20	25	-1	67	81	58	-15	24	41	4	14
3-methyl-2-buten-1-ol	36	196	59	-5	58	101	25	41	176	30	53	19	-25	35	26	4	215	95	42	11	25	37	7	194
1-penten-3-ol	34	124	209	-7	64	58	29	44	37	58	103	39	-35	32	39	-1	8	109	45	20	21	40	-6	-6
1-octen-3-ol	27	9	54	-6	149	121	19	-17	141	100	44	90	-30	15	15	16	164	24	34	40	180	31	-16	197
E2-hexenol	35	180	110	-8	79	87	41	21	223	32	89	31	-33	41	20	4	109	142	16	68	254	63	-8	214
Z2-hexenol	34	151	88	-15	85	111	55	21	202	76	173	30	-34	20	26	-6	105	99	37	9	149	50	-12	92
E3-hexenol	45	154	198	13	74	82	40	29	213	44	55	28	-34	29	32	7	160	102	34	149	241	71	-17	137
Z3-hexenol	29	150	154	-5	84	81	36	30	204	98	79	52	-29	37	42	-6	116	111	34	87	195	55	-16	138
glycerol	2	-2	8	-8	-21	4	-7	15	-4	-18	5	2	-1	0	-4	-3	-2	-1	-4	1	-1	2	8	-2
2,3-butanediol	6	-15	247	-5	-19	50	4	36	4	-11	110	2	-11	-5	10	-6	13	35	24	13	16	9	0	8
methyl acetate	5	-6	24	9	-13	54	2	15	-6	-12	22	25	-21	-5	269	-3	7	7	15	-10	29	12	14	4
ethyl acetate	-3	6	37	6	7	53	2	10	18	8	132	86	-7	15	177	0	43	29	17	65	18	12	5	23
propyl acetate	31	-4	161	67	-1	198	12	13	102	12	174	214	-34	11	66	2	75	63	15	-13	163	48	11	154
butyl acetate	51	-19	151	128	31	212	29	12	63	20	138	205	-38	19	48	23	164	45	36	-11	249	56	0	227
pentyl acetate	35	-4	85	-1	130	158	20	-12	191	12	89	241	-24	8	65	34	216	17	21	30	190	35	9	191
hexyl acetate	29	-19	44	-19	50	172	2	11	206	-3	16	201	-37	-3	39	42	50	2	24	-9	34	2	3	78
isobutyl acetate	31	38	172	212	48	251	9	15	26	25	177	183	-28	-3	44	4	31	73	29	-23	133	39	7	208
isopentyl acetate	65	-33	139	208	81	232	21	6	22	17	96	122	-38	11	46	10	129	48	39	-16	231	27	-1	248
E2-hexenyl acetate	22	204	30	-4	37	194	4	13	227	-17	7	59	-32	6	45	36	73	12	28	0	47	11	-2	203
methyl butyrate	25	-1	143	43	-6	220	2	19	102	10	174	148	-25	20	136	3	115	75	25	3	78	30	8	69
ethyl butyrate	12	1	121	29	73	193	15	37	121	22	199	74	-16	-3	39	-8	167	112	27	125	102	26	-9	81
hexyl butyrate	4	-4	2	-1	6	39	1	4	225	-8	7	17	-17	0	2	8	62	6	10	40	97	1	-7	28
ethyl 3-hydroxybutyrate	53	-27	204	68	30	138	34	0	87	35	146	76	-35	42	35	39	96	89	5	210	235	72	-22	188
ethyl propionate	21	85	58	38	-13	188	-5	81	1	1	168	55	-23	-5	99	4	11	47	18	44	57	26	-5	41
ethyl methanoate	3	108	24	3	-17	13	-5	0	-11	-14	9	-3	-11	3	27	3	-2	1	-2	1	22	8	-5	16
methyl hexanoate	39	40	53	17	36	256	9	-16	-10	3	58	210	-33	12	2	19	87	21	18	-16	228	33	-27	188
ethyl hexanoate	22	-13	20	-14	42	224	13	0	-21	6	4	138	-31	-2	-8	7	143	-3	10	-22	89	10	-11	55
hexyl hexanoate	1	-4	-3	-1	-25	31	-4	1	126	-14	-1	-1	4	-1	7	-2	-3	-4	-3	5	17	9	3	5
methyl octanoate	1	-7	4	-13	0	237	-3	3	10	-13	4	58	-26	4	-8	22	-7	2	16	-12	62	1	-8	23
ethyl octanoate	1	-7	2	-14	-8	95	-4	-4	-12	-12	3	18	-7	-6	-2	7	-10	1	5	-8	39	1	-5	22
ethyl decanoate	5	-12	2	43	-17	6	-1	1	-10	-8	7	-3	-3	-2	3	-4	-7	-3	-4	-20	28	-2	-5	12
ethyl trans-2-butenoate	11	-2	103	146	9	210	9	-4	14	-22	191	44	-33	3	-7	2	104	34	16	91	80	24	-9	243
ethyl lactate	39	31	75	31	24	70	11	2	5	7	93	29	-28	34	133	31	39	288	42	39	77	77	-7	66
diethyl succinate	16	-11	21	-13	24	205	26	-8	-20	-8	4	36	-16	-3	-9	5	175	7	32	-12	35	12	5	4
spontaneous firing rate	8	17	3	14	29	4	9	25	17	21	2	1	47	8	2	18	11	6	16	14	13	7	26	12

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Table S2

	2a	7a	9a	10a	19a	22a	23a	33b	35a	43a	43b	47a	47b	49b	59b	65a	67a	67c	82a	85a	85b	85f	88a	98a
ethyl acetate -2	-3	6	37	6	7	53	2	10	18	8	132	86	-7	15	177	0	43	29	17	65	18	12	5	23
pentyl acetate -2	35	-4	85	-1	130	158	20	-12	191	12	89	241	-24	8	65	34	216	17	21	30	190	35	9	191
ethyl butyrate -2	12	1	121	29	73	193	15	37	121	22	199	74	-16	-3	39	-8	167	112	27	125	102	26	-9	81
methyl salicylate -2	5	-6	13	258	1	-2	-1	-7	2	20	12	-6	6	48	-4	-13	35	-2	-5	2	-8	5	-7	8
1-hexanol -2	40	96	102	10	146	63	51	1	237	133	73	58	-35	31	35	7	173	109	58	137	183	64	16	158
1-octen-3-ol -2	27	9	54	-6	149	121	19	-17	141	100	44	90	-30	15	15	16	164	24	34	40	180	31	-16	197
E2-hexenal -2	17	221	38	-8	58	49	45	-8	227	41	84	37	18	6	3	-2	117	47	-6	11	145	35	-8	28
2,3-butanedione -2	3	13	60	22	35	48	15	11	13	11	69	25	7	6	97	8	84	42	20	40	71	14	11	34
2-heptanone -2	39	-2	106	17	131	111	25	0	119	42	71	209	-10	21	25	35	170	36	32	33	190	40	19	189
geranyl acetate -2	2	1	-5	-8	9	1	4	0	-3	-10	10	-2	-1	-4	37	-7	7	-3	241	-1	-2	-2	1	81
ethyl acetate -4	-4	10	19	9	-6	18	-5	15	-3	-9	11	18	-13	-4	55	-1	-6	1	12	6	14	12	-4	0
pentyl acetate -4	5	3	10	-6	-4	109	2	-14	47	-4	25	220	-11	1	3	8	74	-4	-3	-1	150	15	0	41
ethyl butyrate -4	-4	2	14	-1	-6	152	-5	14	-2	-2	56	17	-9	1	0	-1	30	6	10	42	12	1	0	3
methyl salicylate -4	-5	-6	-1	220	-2	7	-2	-3	9	-5	2	3	-4	1	0	-3	-3	-1	3	6	0	-4	-3	-1
1-hexanol -4	1	5	6	-5	-6	15	0	-3	264	-4	18	12	-4	-2	2	-1	8	3	6	15	105	1	-5	17
1-octen-3-ol -4	5	0	1	-4	-1	32	-2	-4	11	-3	4	20	-3	-7	0	2	9	-4	4	8	63	-2	-3	56
E2-hexenal -4	-1	251	0	-4	2	1	0	-3	19	1	3	4	-3	1	2	-1	8	1	2	-1	-1	3	-4	3
2,3-butanedione -4	-1	2	5	1	-9	5	-5	11	0	-7	4	6	-4	-7	26	0	-7	1	9	0	34	0	-2	4
2-heptanone -4	35	9	28	-8	-3	46	15	-25	38	14	29	78	-8	13	24	24	36	8	6	3	204	22	24	79
geranyl acetate -4	-3	7	-1	-7	6	-1	-1	0	-2	-3	2	0	-2	0	0	0	-1	-3	35	3	-2	-2	0	19
ethyl acetate -6	-1	14	1	-2	4	2	0	0	-3	6	3	3	0	0	0	0	7	3	-7	5	2	-3	6	2
pentyl acetate -6	-4	10	2	1	3	13	1	1	3	10	1	89	3	0	1	0	6	-2	-10	-2	2	0	5	-6
ethyl butyrate -6	0	9	0	-1	3	22	3	1	-4	11	9	0	2	-4	0	2	-7	2	-5	3	-1	-5	2	3
methyl salicylate -6	-1	8	0	84	1	3	-3	1	0	13	3	-1	4	2	1	2	7	4	-9	2	3	-3	1	-7
1-hexanol -6	-4	8	2	2	0	1	-2	-2	220	8	-1	-2	-1	4	1	1	-3	1	-6	-1	1	0	4	1
1-octen-3-ol -6	0	10	0	-5	-2	5	4	2	-14	4	1	-2	2	0	2	5	5	3	-4	4	1	-3	3	-5
E2-hexenal -6	4	204	0	3	-5	10	-4	6	-7	6	3	-3	5	-2	1	1	0	-6	-5	2	-5	-1	5	-2
2,3-butanedione -6	3	2	1	3	-2	6	5	6	-2	7	6	-1	4	2	0	1	-2	3	-3	3	2	-6	6	-4
2-heptanone -6	2	-4	15	14	-2	25	6	-22	8	12	29	26	5	3	9	-4	-4	5	-2	5	156	19	15	-6
geranyl acetate -6	0	4	0	-8	2	7	-1	2	-8	12	1	-2	3	1	-2	4	-2	5	-11	-2	2	-1	-1	0
ethyl acetate -8	4	-5	-4	6	14	-3	-4	1	-1	7	3	10	1	0	2	0	0	-4	-5	-1	-4	3	-2	-5
pentyl acetate -8	5	-9	-4	-4	7	0	-4	-2	2	6	0	13	2	-1	2	2	-2	-3	-1	4	-4	0	0	-8
ethyl butyrate -8	-2	-10	-4	5	5	0	-6	4	3	9	-1	3	1	-1	1	1	3	-6	-6	4	-8	2	0	-2
methyl salicylate -8	1	-12	-2	5	5	0	-7	-1	8	3	0	4	-3	-4	0	-1	1	-5	2	0	-14	4	-3	-10
1-hexanol -8	-1	-10	-3	3	2	-2	-7	5	30	2	0	-2	2	-3	4	1	-1	-5	-7	-2	-10	2	1	-5
1-octen-3-ol -8	9	-8	-5	2	4	0	-13	1	8	5	-3	3	0	-2	-1	5	0	-5	-2	2	-5	3	2	-7
E2-hexenal -8	6	23	-3	-1	3	-1	0	2	4	1	2	0	2	-1	-5	3	1	4	-8	1	-8	-2	8	-10
2,3-butanedione -8	2	-12	-3	-3	0	-1	2	5	0	0	8	-1	2	-3	-1	3	-2	-7	-8	7	-3	1	4	-8
2-heptanone -8	11	-7	0	0	1	0	-6	3	10	2	1	-2	2	2	4	1	-2	2	-10	4	17	6	1	-9
geranyl acetate -8	2	-5	-3	3	5	-3	-9	-2	-2	-4	3	2	3	-3	2	3	2	1	-6	-2	-3	3	3	-2
apple pure	40	210	126	28	73	248	68	6	130	76	158	250	-13	20	165	15	198	158	40	87	203	112	49	135
apricot pure	10	165	71	5	56	139	30	-3	40	47	48	115	-16	16	146	5	94	78	28	26	55	70	34	42
banana pure	55	203	255	117	126	245	77	10	89	112	247	238	-26	26	158	26	209	213	28	80	213	97	19	175
cherry pure	5	206	42	43	47	130	25	-8	83	68	51	94	-15	91	65	9	170	83	26	25	23	68	9	4
mango pure	15	143	75	49	104	243	39	-2	60	51	95	108	-10	12	106	9	151	90	28	162	94	67	21	98
peach pure	16	159	84	1	47	161	27	-5	78	52	49	106	-13	26	135	7	108	76	31	24	31	60	8	20
pineapple pure	13	136	133	30	38	234	27	-3	51	59	82	144	-6	14	151	9	125	84	29	85	92	67	7	23
raspberry pure	19	181	109	42	63	234	57	-3	78	44	59	114	-23	24	140	13	119	97	42	30	195	80	-6	98
strawberry pure	35	197	157	116	47	237	67	-3	90	51	126	183	-19	27	172	18	171	149	27	123	196	77	-9	32
apple -2	9	183	32	20	26	138	22	10	182	15	45	122	-19	2	42	22	181	30	26	51	169	6	0	62
apricot -2	-4	38	2	-2	-7	20	-5	-6	4	4	-2	15	-11	4	30	3	58	3	-1	11	8	-4	-4	1
banana -2	31	200	58	19	22	118	23	-5	109	23	88	119	-16	3	44	18	198	100	12	48	164	14	10	33
cherry -2	-1	109	0	19	-4	17	2	-1	63	2	2	9	-2	8	6	1	119	5	7	3	-5	-4	3	-7
mango -2	6	25	3	15	16	105	0	-4	29	0	10	16	-17	5	9	2	101	5	9	53	32	-5	-4	21
peach -2	-2	39	2	4	1	35	0	-4	42	1	2	15	-11	7	29	4	48	2	11	1	7	1	-2	-8
pineapple -2	-2	16	14	11	-2	100	5	0	10	6	-1	22	-7	4	27	1	85	4	5	18	21	-3	-1	-6
raspberry -2	6	128	8	27	1	80	-1	-2	71	-3	3	28	-10	7	24	5	69	8	14	14	136	-2	-4	33
strawberry -2	18	168	23	45	9	139	2	-3	102	0	7	50	-6	3	28	13	126	26	7	50	162	-1	5	7
apple -4	3	123	7	12	-5	38	1	4	82	6	-4	26	-5	5	2	8	6	1	6	2	22	11	-14	9
apricot -4	7	7	1	-3	-5	1	4	-4	-2	8	-4	0	-3	7	1	-2	-1	1	-2	5	-1	0	-11	3
banana -4	19	101	22	16	-2	17	8	-4	16	18	17	30	-9	4	8	21	20	10	0	3	91	16	8	14
cherry -4	4	2	0	-9	-7	0	-1	7	0	4	1	1	-7	8	-1	-2	-12	4	-2	0	-8	2	-2	0
mango -4	4	4	1	-3	-5	21	0	1	-2	8	0	4	-1	3	-1	3	-13	5	2	-8	-9	3	-3	0
peach -4	1	0	2	-7	0	-1	4	-5	5	4	-4	2	-4	9	5	4	-10	4	8	2	-9	2	2	-2
pineapple -4	2	3	5	-3	-3	21	-5	-2	-3	3	-4	5	-1	7	0	8	-13	4	-3	-9	-2	0	2	-5
raspberry -4	14	4	2	-5	-4	10	-2	2	2	6	0	6	1	7	-1	3	-11	2	3	-5	7	4	4	-2
strawberry -4	17	11	2	2	0	64	-1	-1	15	-5	-2	7	-4	8	-1	10	-1	3	8	5	18	3	1	-2
apple -6	-1	10	3	8	-7	7	1	-8	17	4	1	10	-12	5	0	0	8	-5	-8	-6	-3	-1	-4	4
apricot -6	-2	6	-1	-3	-5	-2	1	-6	8	13	-1	6	-10	1	-1	-2	6	-7	-2	-1	-6	-5	-7	-2
banana -6	-3	10	1	1	-6	1	0	-4	4	12	-3	7	-8	3	-1	-5	-4	-2	-2	-6	-6	-6	-1	0
cherry -6	-4	7	4	3	-3	2	2	-2	1	12	5	7	-7	6	1	-6	-5	-6	6	-4	-2	-4	-4	-6
mango -6	-5	6	1	3	-7	4	2	-6	3	3	5	12	-6	6	1	-4	3	-12	-2	0	-5	-7	-1	-5
peach -6	0	0	0	9	-7	0	1	-8	6	5	0	13	1	-3	0	-1	-2	-6	-9	-1	-3	-6	1	-5
pineapple -6	-5	1	-1	4	0	1	3	-2	1	12	5	5	-8	3	3	0	10	-3	-8	-3	-3	-6	-5	-6
raspberry -6	3	1	1	10	-7	-1	-3	-5	3	8	-3	3	-19	2	-2	-1	5	-1	-2	1	-6	-1	-3	-2
strawberry -6	-3	-4	2	6	1	5	0	-3	2	1	7	4	-8	2	3	-1	-1	-2	-5	-1	-7	-6	-6	-3

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Table S3

A. Responses to methyl salicylate at 10^{-2}

	0.0 s	0.5 s	1.0 s	1.5 s
Or10a	264.33	233.00	218.67	200.67
Or19a	53.67	23.67	21.67	16.33
Or49b	48.33	0.00	0.33	0.67
Or43a	47.33	3.33	0.33	7.00
Or67a	34.67	1.00	-3.00	-0.67
Or98a	27.33	0.67	-0.67	-2.67
Or7a	16.33	1.67	-0.33	1.00
Or9a	14.67	0.67	-0.33	0.33
Or35a	13.00	12.33	5.00	3.33
Or85b	13.00	5.33	-2.33	1.33
Or43b	7.67	1.33	3.33	1.33
Or2a	5.67	-2.00	1.33	-0.33
Or47b	4.33	-0.33	-0.67	2.33
Or85f	4.33	-6.33	-3.33	-5.33
Or23a	3.67	-9.00	-8.00	-8.33
Or85a	3.00	3.67	2.67	-0.33
Or82a	2.33	-1.33	-2.33	-1.33
Or67c	-1.67	0.00	1.33	1.33
Or22a	-2.33	0.00	6.00	5.33
Or59b	-2.67	-1.00	-2.67	-0.33
Or47a	-3.33	6.67	11.67	6.33
Or33b	-4.00	-5.00	-3.67	-4.33
Or65a	-9.67	-3.00	1.00	-1.67
Or88a	-9.67	-0.67	0.67	-1.00

B. Responses to methyl salicylate at 10^{-4}

	0.0 s	0.5 s	1.0 s	1.5 s
Or10a	221.67	153.00	85.33	66.33
Or19a	44.00	40.00	24.00	18.00
Or49b	2.00	2.67	1.67	1.67
Or43a	19.00	9.33	5.00	2.67
Or67a	-1.33	-3.00	-2.67	-0.33
Or98a	16.00	-1.67	-0.67	-1.33
Or7a	0.00	-2.00	1.67	1.33
Or9a	0.33	-0.33	0.00	0.33
Or35a	19.00	6.67	2.67	-3.33
Or85b	32.33	-0.33	-5.33	-4.33
Or43b	0.67	-1.00	-0.33	-0.33
Or2a	-1.33	-2.00	-0.67	-5.67
Or47b	-1.00	-2.33	0.67	0.67
Or85f	-1.67	-1.67	-4.67	-2.00
Or23a	1.00	-2.33	2.33	-2.67
Or85a	-1.33	0.33	2.00	-0.67
Or82a	12.33	2.33	1.67	2.67
Or67c	2.00	0.33	-4.33	0.33
Or22a	16.00	0.00	0.67	-0.67
Or59b	-0.33	-1.67	-0.67	-1.00
Or47a	4.67	2.67	1.00	1.00
Or33b	3.33	-1.67	1.00	2.00
Or65a	-2.33	-0.67	-0.33	0.33
Or88a	2.00	-2.33	-1.00	-3.00

C. Responses to pentyl acetate at 10^{-2}

	0.0 s	0.5 s	1.0 s	1.5 s
Or47a	249.33	228.33	209.33	174.67
Or98a	215.00	60.67	7.67	-0.67
Or85b	211.33	164.67	117.67	98.33
Or67a	210.33	112.67	57.67	33.67
Or35a	202.33	167.33	98.67	69.00
Or19a	182.00	33.67	13.67	12.00
Or22a	156.00	51.00	46.00	40.00
Or9a	86.33	3.33	4.00	3.33
Or43b	85.00	9.67	1.67	-0.67
Or59b	66.33	16.00	4.67	3.00
Or43a	38.67	-4.67	-3.33	-3.33
Or65a	37.33	-13.00	-11.33	-7.33
Or2a	35.67	-9.00	-5.33	-4.00
Or85f	33.67	2.33	0.00	-3.33
Or85a	31.33	6.33	6.33	-1.00
Or82a	28.33	-6.00	-6.00	-5.67
Or23a	24.67	0.67	-8.00	-6.33
Or67c	17.67	0.00	-0.33	-1.67
Or49b	13.00	6.33	4.67	5.67
Or7a	12.67	8.00	-2.33	-2.00
Or10a	12.00	15.33	3.33	3.33
Or88a	7.00	-5.67	-9.00	-3.33
Or33b	-8.67	-5.00	-0.33	7.33
Or47b	-26.00	0.00	-5.00	-4.33

D. Responses to pentyl acetate at 10^{-4}

	0.0 s	0.5 s	1.0 s	1.5 s
Or47a	222.33	51.00	16.00	12.33
Or98a	57.67	-8.67	-1.00	-1.67
Or85b	182.33	16.67	2.67	3.00
Or67a	75.67	-13.67	-9.67	-8.00
Or35a	56.33	21.33	5.33	2.00
Or19a	42.33	39.67	25.67	19.00
Or22a	117.67	7.00	5.67	2.67
Or9a	11.67	-3.00	1.00	1.33
Or43b	24.33	1.00	1.33	2.00
Or59b	2.00	-1.33	-1.00	-1.00
Or43a	20.67	10.00	4.00	2.67
Or65a	8.33	-0.67	3.33	3.67
Or2a	7.00	3.67	5.00	13.33
Or85f	17.67	-2.00	-0.33	0.00
Or85a	-7.67	4.00	0.00	2.33
Or82a	6.00	-4.67	-2.67	1.00
Or23a	4.67	-3.33	-2.67	-1.67
Or67c	-0.67	-3.33	-2.00	-1.33
Or49b	2.33	0.67	1.67	-1.00
Or7a	8.67	4.00	3.33	0.33
Or10a	-4.00	-7.00	-1.33	-1.00
Or88a	5.33	-3.67	5.00	2.00
Or33b	-7.33	-10.33	-6.67	-2.67
Or47b	-8.00	-3.00	0.33	0.67

E. Responses to 2-heptanone at 10^{-2}

	0.0 s	0.5 s	1.0 s	1.5 s
Or47a	211.67	140.00	88.67	43.00
Or85b	211.33	191.67	187.00	191.33
Or98a	208.00	56.33	13.67	8.33
Or19a	183.67	44.33	31.67	24.67
Or67a	169.67	59.33	34.67	22.33
Or35a	130.00	134.67	138.67	121.67
Or22a	109.00	21.33	8.00	5.00
Or9a	108.33	21.33	18.33	12.33
Or43a	68.67	5.33	2.33	7.33
Or43b	67.00	14.00	9.00	5.00
Or2a	39.33	8.67	7.00	6.67
Or82a	39.33	0.00	-5.33	-0.33
Or85f	38.67	8.33	5.67	4.00
Or65a	38.33	1.67	-0.67	-4.33
Or67c	36.00	0.67	2.67	0.33
Or85a	33.67	20.67	15.00	10.33
Or23a	29.67	7.67	6.00	3.00
Or59b	26.67	14.00	7.00	4.67
Or10a	23.33	9.33	16.00	7.33
Or49b	21.67	8.33	5.33	0.00
Or88a	16.67	14.67	5.33	3.00
Or7a	13.33	2.67	3.67	1.33
Or33b	3.00	0.33	-10.67	-10.00
Or47b	-11.67	-7.33	-9.67	-3.67

F. Responses to 2-heptanone at 10^{-4}

	0.0 s	0.5 s	1.0 s	1.5 s
Or47a	80.00	-2.67	-2.33	-2.00
Or85b	236.33	218.00	137.33	83.33
Or98a	96.00	-9.67	-7.67	-5.00
Or19a	43.67	35.67	19.00	12.33
Or67a	38.33	-11.67	-10.33	-9.67
Or35a	47.33	34.00	7.00	2.33
Or22a	54.33	8.67	4.67	2.33
Or9a	29.67	2.33	2.00	0.67
Or43a	38.00	20.00	6.00	2.67
Or43b	27.67	-2.00	1.00	-2.00
Or2a	38.67	3.33	-2.67	-1.00
Or82a	15.00	-9.67	-7.33	-6.00
Or85f	24.33	6.00	-4.00	-1.33
Or65a	24.33	-1.00	-5.67	-3.67
Or67c	11.33	-3.67	-4.33	-6.00
Or85a	-4.33	-9.00	-2.33	-4.00
Or23a	17.67	-4.00	-6.00	-1.00
Or59b	23.00	1.00	-0.33	0.00
Or10a	-5.67	-10.33	1.33	3.33
Or49b	14.33	-0.67	-3.00	-1.67
Or88a	29.00	9.67	2.33	5.00
Or7a	15.33	3.00	-5.33	-5.00
Or33b	-18.67	-16.00	-5.33	-0.33
Or47b	-4.33	-6.33	-8.00	-5.67

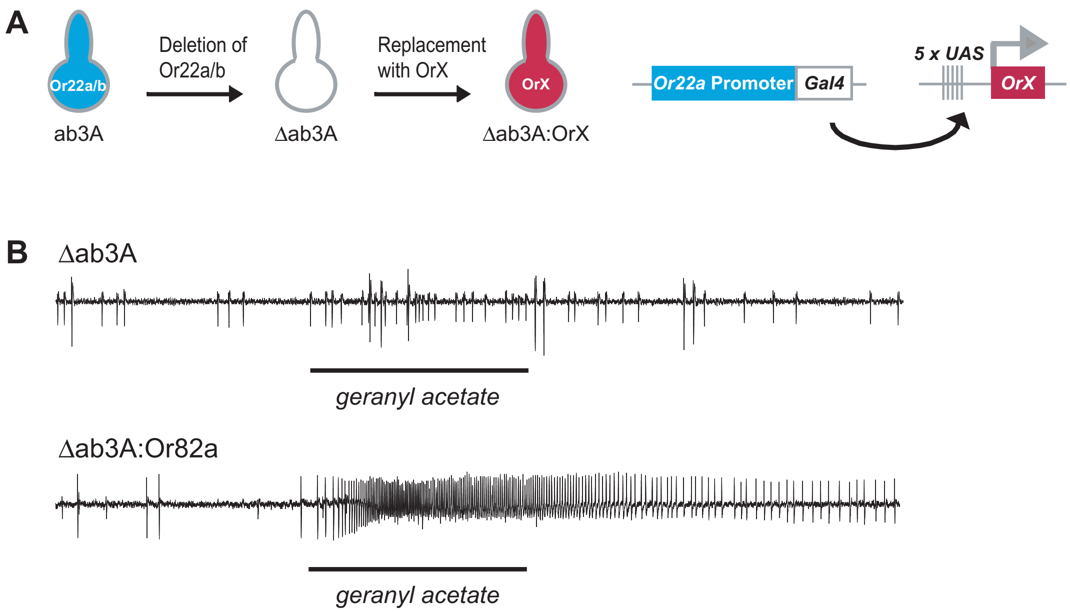
G. Responses to apple at 10^{-2}

	0.0 s	0.5 s	1.0 s	1.5 s
Or85b	232.67	64.00	23.67	16.00
Or7a	222.67	75.67	28.00	20.00
Or35a	217.33	170.67	98.67	67.00
Or67a	206.00	33.67	1.00	7.00
Or22a	154.33	22.33	30.67	31.00
Or47a	124.33	5.00	5.00	3.33
Or98a	121.00	53.33	31.00	21.67
Or10a	75.67	0.33	-3.67	-2.33
Or43b	69.33	12.00	-2.00	-2.00
Or85a	59.33	9.67	9.67	7.33
Or82a	53.67	22.00	11.00	9.33
Or59b	39.67	4.67	-3.33	-4.00
Or9a	32.67	4.00	2.67	5.33
Or19a	30.67	-4.00	0.00	0.67
Or23a	28.33	10.00	-6.67	2.33
Or67c	27.00	15.33	7.33	5.67
Or43a	24.33	3.67	0.33	2.33
Or65a	18.67	-5.33	-2.33	-2.67
Or2a	9.33	2.00	5.00	3.33
Or85f	8.33	7.67	2.33	3.00
Or33b	7.33	-7.33	-1.00	1.67
Or49b	-1.33	-4.67	0.67	0.67
Or88a	-3.00	-5.00	2.67	2.00
Or47b	-14.00	-4.67	1.00	2.00

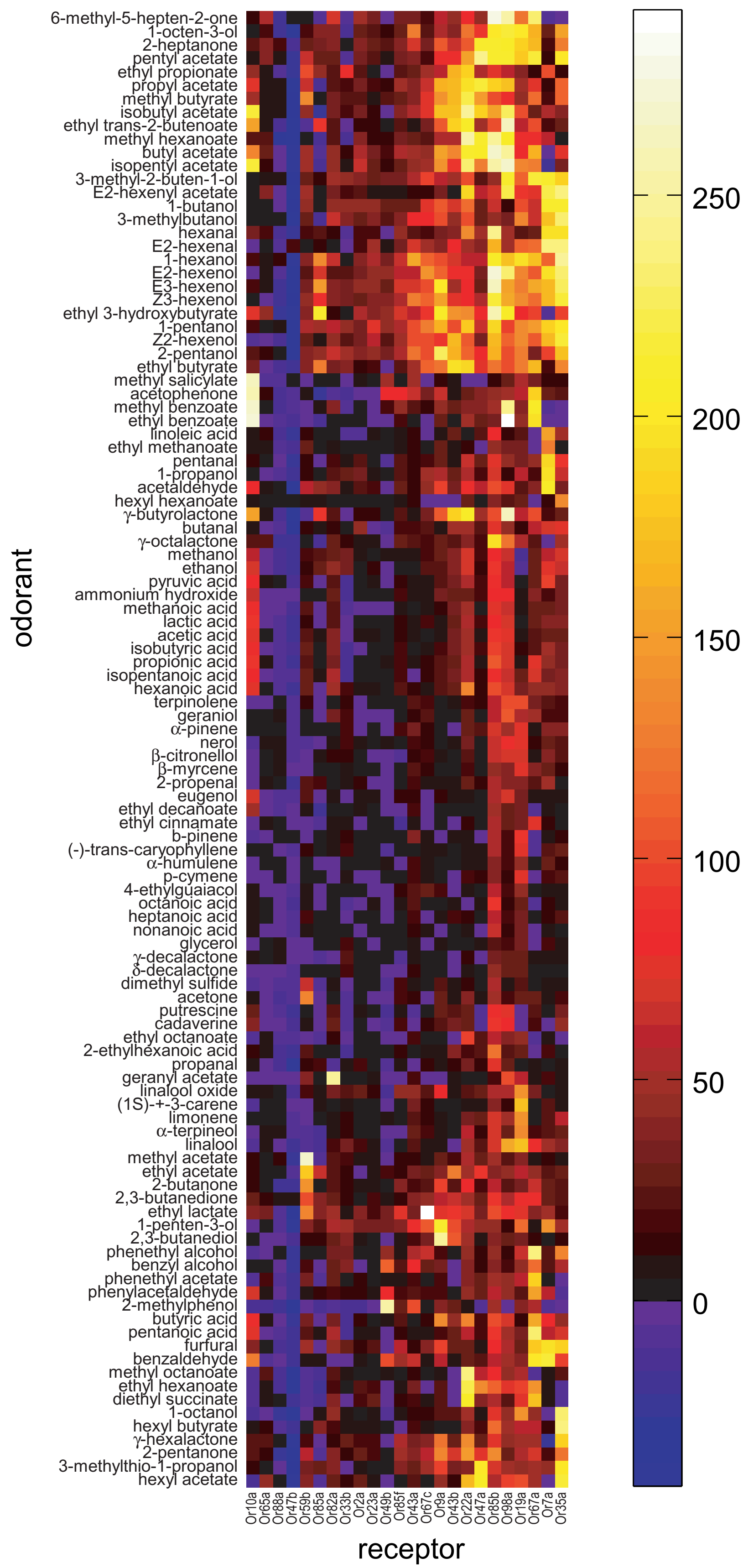
H. Responses to apple at 10^{-4}

	0.0 s	0.5 s	1.0 s	1.5 s
Or85b	104.33	18.67	-0.67	-1.33
Or7a	147.67	-14.00	-7.33	-6.33
Or35a	118.00	35.67	15.00	11.67
Or67a	40.00	1.33	2.00	0.67
Or22a	81.00	1.33	3.33	-1.00
Or47a	37.33	0.00	-1.00	1.00
Or98a	78.33	15.67	6.33	2.33
Or10a	81.33	1.67	1.00	2.00
Or43b	14.33	1.33	-0.33	0.00
Or85a	10.33	3.67	-0.33	5.33
Or82a	35.33	25.00	15.00	6.00
Or59b	2.67	1.33	1.00	1.33
Or9a	9.00	-0.33	1.67	2.33
Or19a	19.33	7.67	-0.67	2.67
Or23a	-1.33	1.67	13.67	10.67
Or67c	4.67	3.67	3.33	1.00
Or43a	2.33	10.67	0.67	-1.00
Or65a	18.00	5.00	-0.67	-2.33
Or2a	1.33	-3.33	0.00	-1.67
Or85f	13.00	4.00	-1.00	1.00
Or33b	0.00	-3.00	5.00	6.67
Or49b	1.33	3.00	-1.67	0.00
Or88a	-2.67	-2.67	2.33	2.67
Or47b	-10.00	-4.33	-1.67	0.00

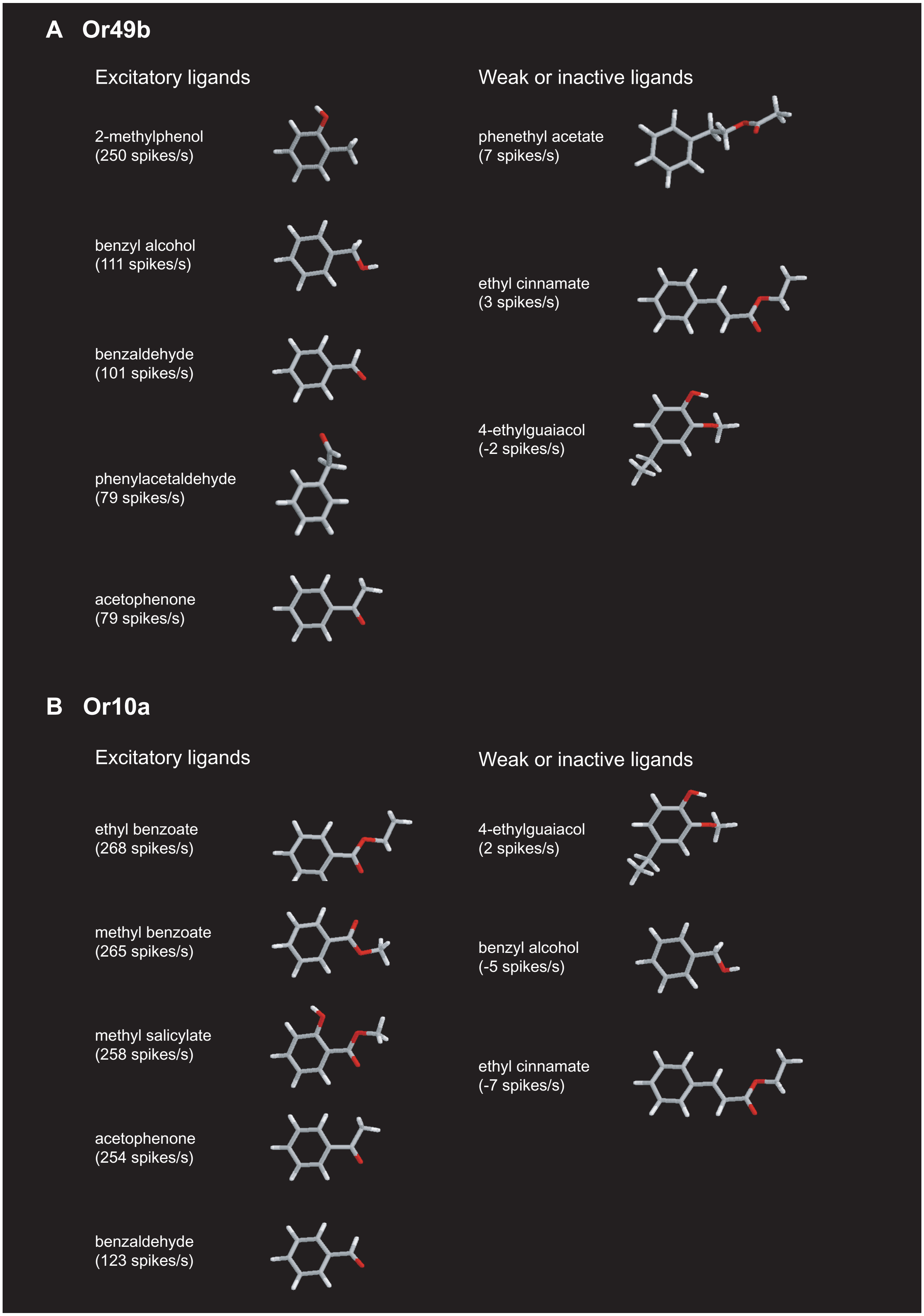
Hallem and Carlson
Figure S1

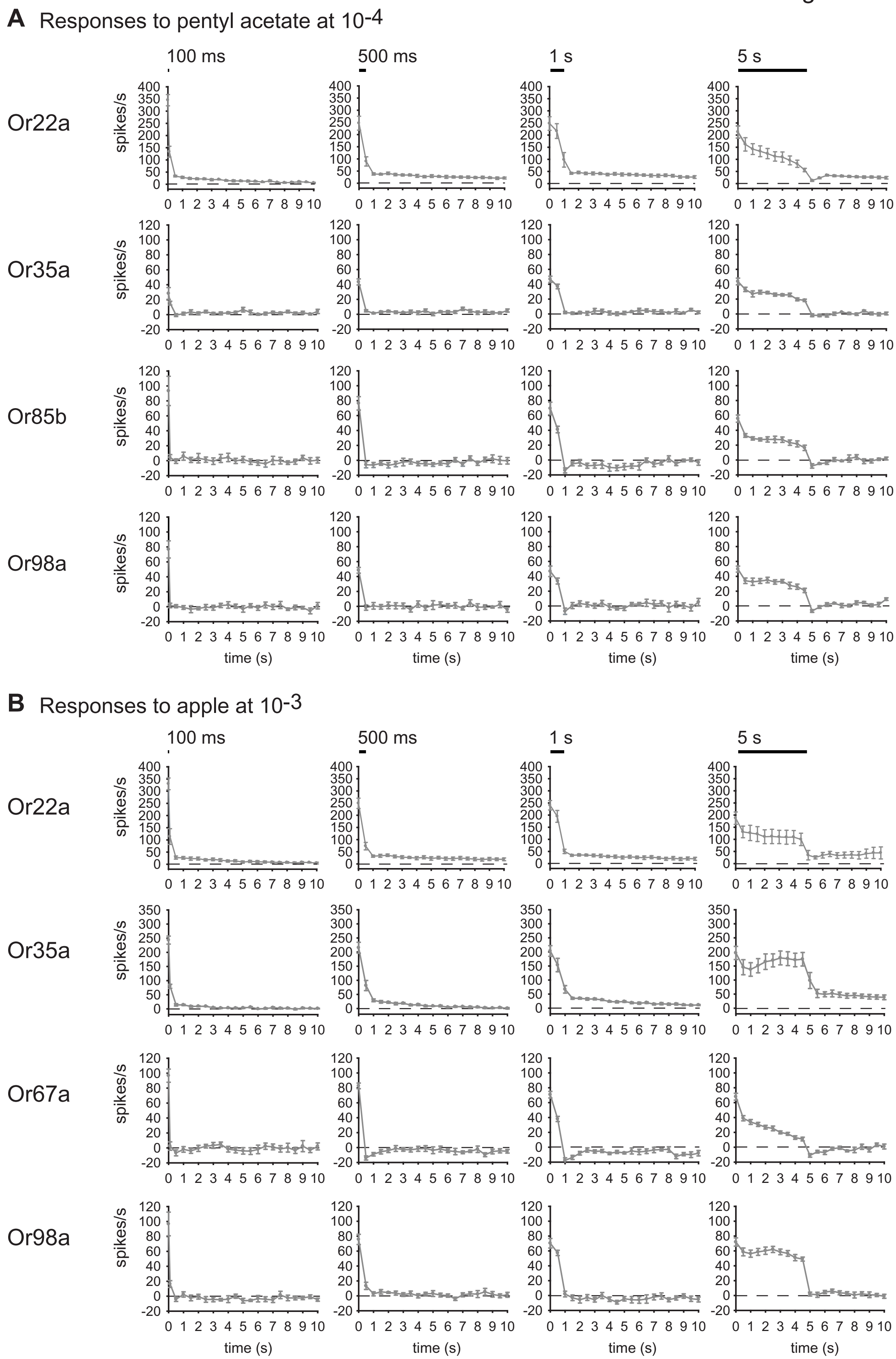


Hallem and Carlson
Figure S2



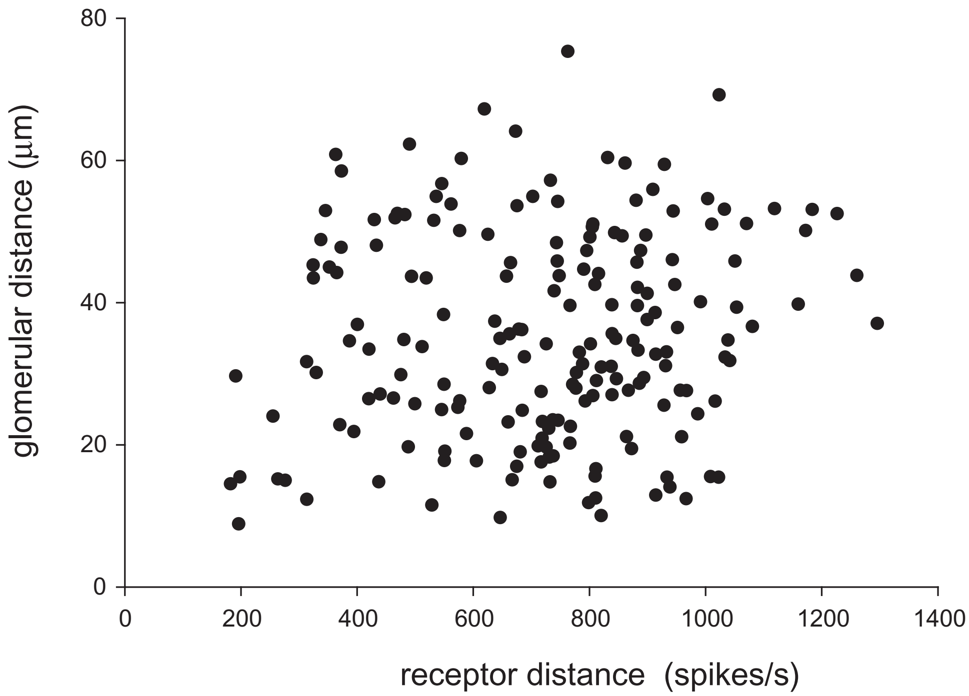
Hallem and Carlson
Figure S3



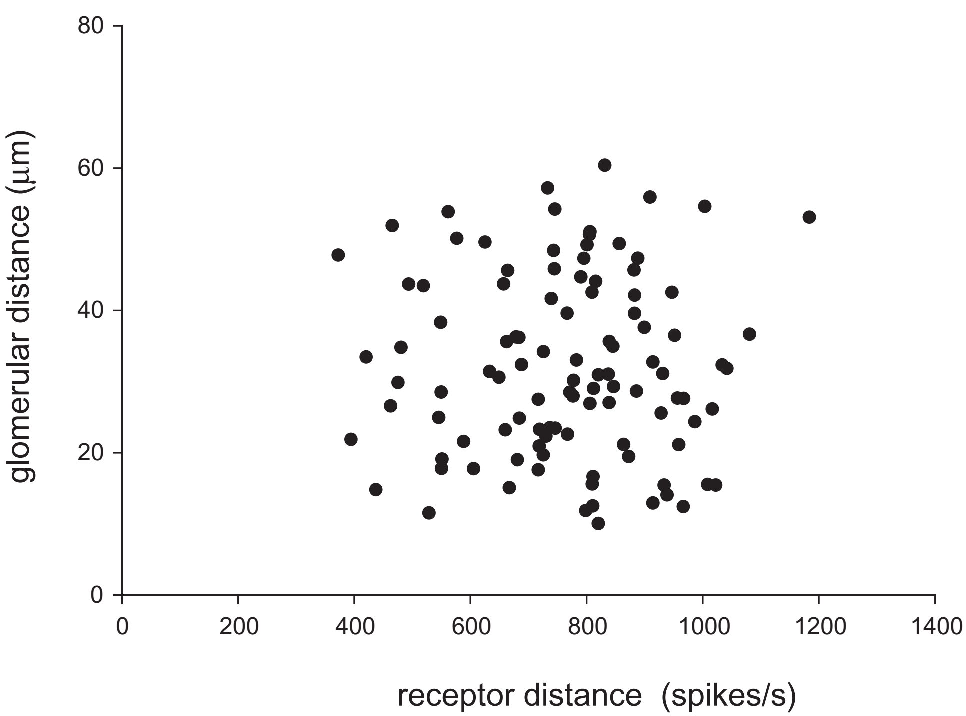

A Responses to pentyl acetate at 10-4
100 ms
500 ms
1 s
5 s
Or22a
Or35a
Or85b
Or98a
spikes/s
time (s)
B Responses to apple at 10-3
100 ms
500 ms
1 s
5 s
Or22a
Or35a
Or67a
Or98a
spikes/s
time (s)

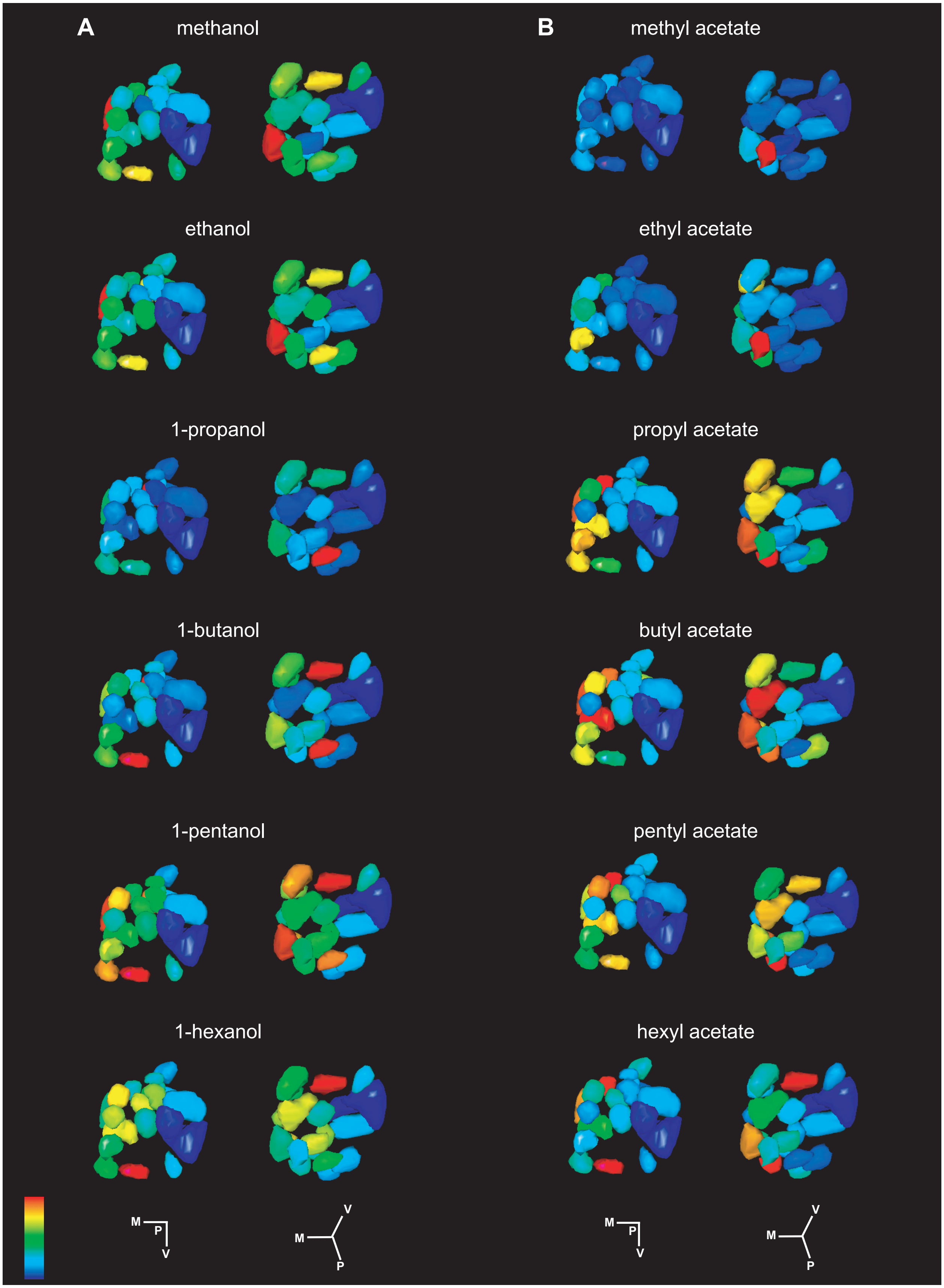
Hallem and Carlson
Figure S5

A



B




A
methanol
ethanol
1-propanol
1-butanol
1-pentanol
1-hexanol
B
methyl acetate
ethyl acetate
propyl acetate
butyl acetate
pentyl acetate
hexyl acetate
M
P
V
M
V
P
M
P
V
M
V
P

Hallem and Carlson
Figure S7