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Supplemental Information

Deconstructing the mouse olfactory percept through an ethological atlas

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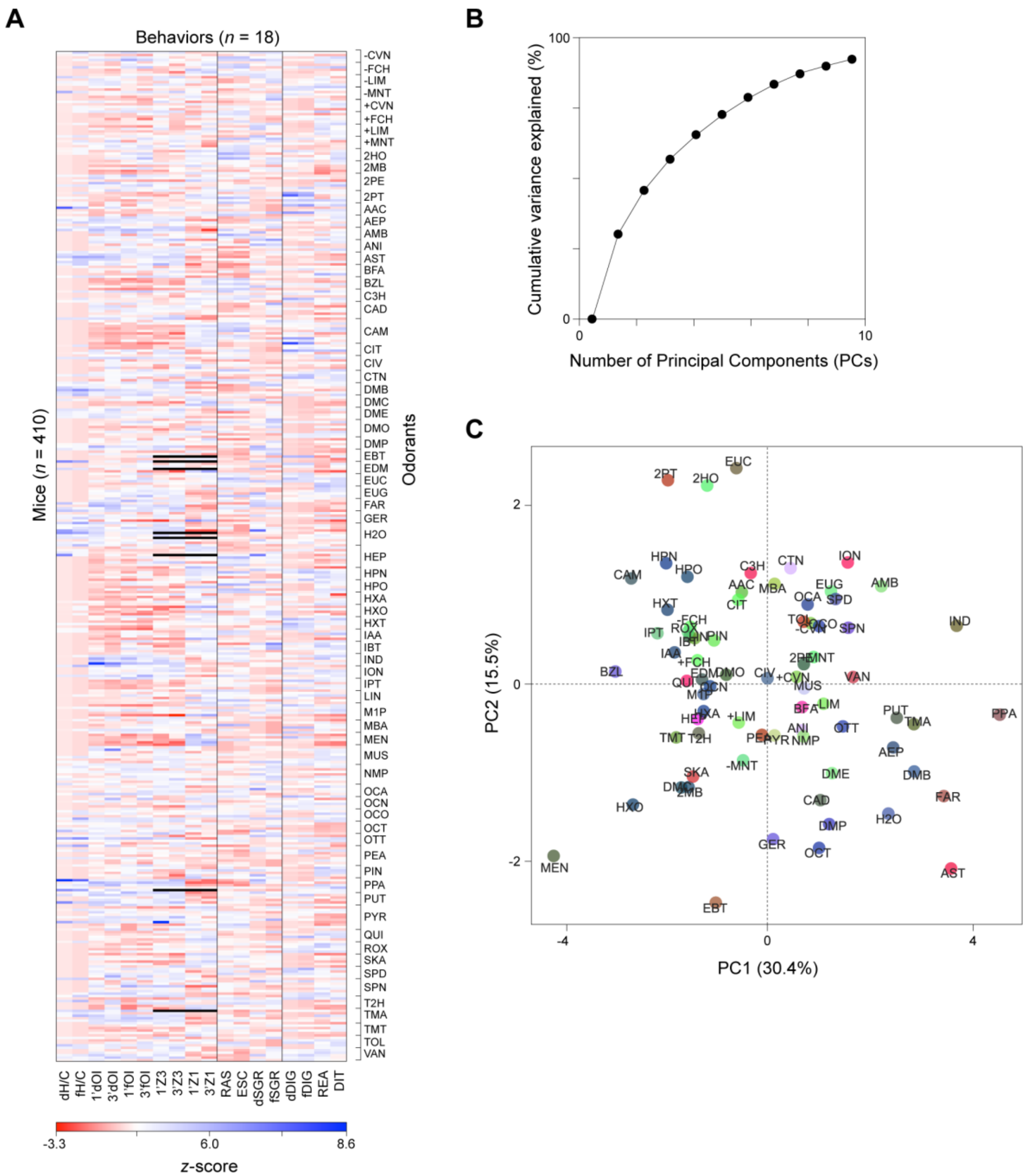

Figure S1. An olfactory-ethological atlas and primary axis of olfactory perception in the mouse, related to Figure 1. (**A**) Heatmap summarizing the 7380-individual z-scores representing of 18 mouse behavioral responses to 73 odorants (*n* = 410 mice). **(B)** Cumulative variance explained by the principal components (PCs). **(C)** Principal Component Analysis of the 18 mouse behavioral parameters for H_2O and the 73 tested odorants (*n* = 3-7 per odorant). Circles are colored according to their chemical structure similarity, which was computed using Morgan fingerprints (see STAR Methods). See also Figure 1, and Data S1.

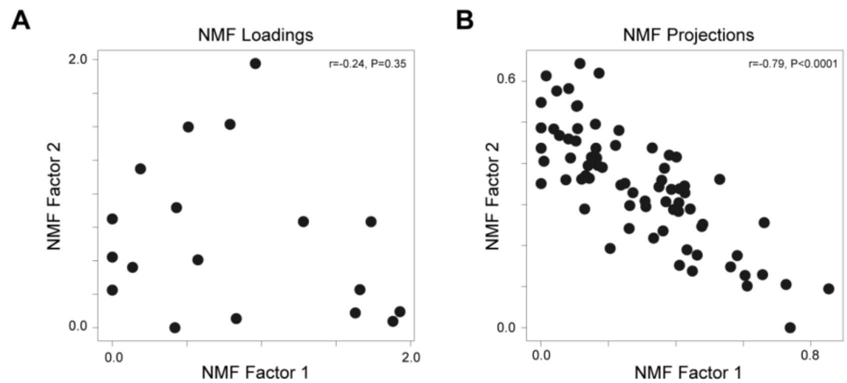

Figure S2. Details of the non-negative matrix factorization (NMF) used in Figure 3, related to Figures 2 and 3. (A) Behavioral loadings for each of the first two NMF factors. Each point reflects the loading for one of the 18 behaviors. **(B)** Projection of the behavioral data for all odorants into a space comprising these factors. Each point reflects one of the 73 odorants. These two factors are highly negatively correlated, suggesting that they mostly describe opposing valence factors (e.g. approach vs avoid). See also Figures 2, S3, and Table S1.

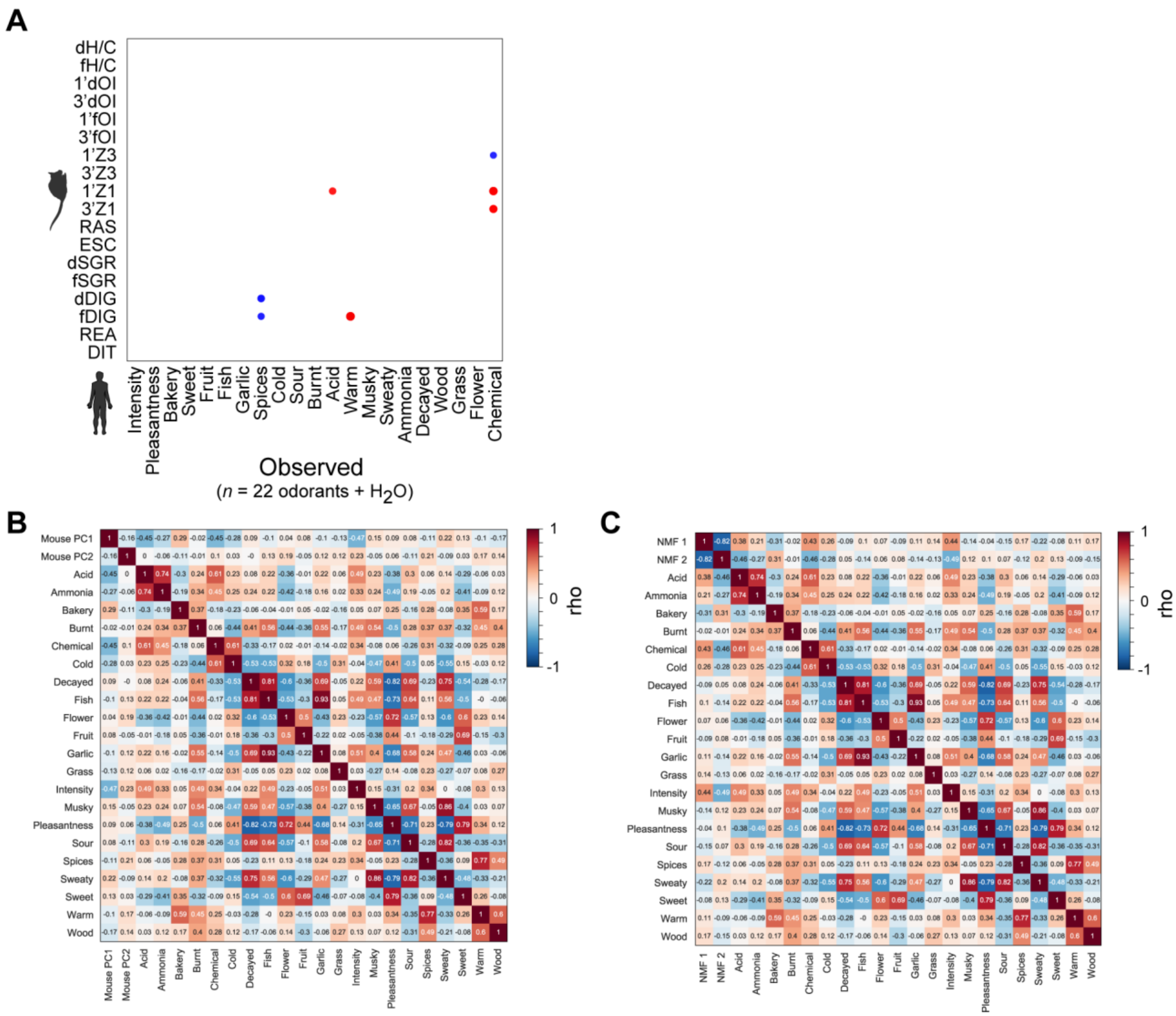

Figure S3. Comparing the mouse and human olfactory percepts, related to Figures 3 and 4. (A) Correlogram between the 18 mouse behavioral parameters and 21 human ratings for the 23 odorants overlapping between this study and [S1]. Only significant ($P < 0.05$) correlations are plotted, and the circle size and color indicate the magnitude and direction of the correlation (Spearman ϱ). Blank cells correspond to non-significant correlations. (**B**) Correlation between each of the 21 human-rated perceptual descriptors for 73 odorants (the 22 odorants common to this study and [S1] as well as the 51 odorants predicted using [S2] and i) the descriptors themselves and ii) the principal components from Fig. 1. (**C**) Same as Fig S3B, but for NMF factors in Fig. 3. See also Figures 2, 4, S2, and Table S1.

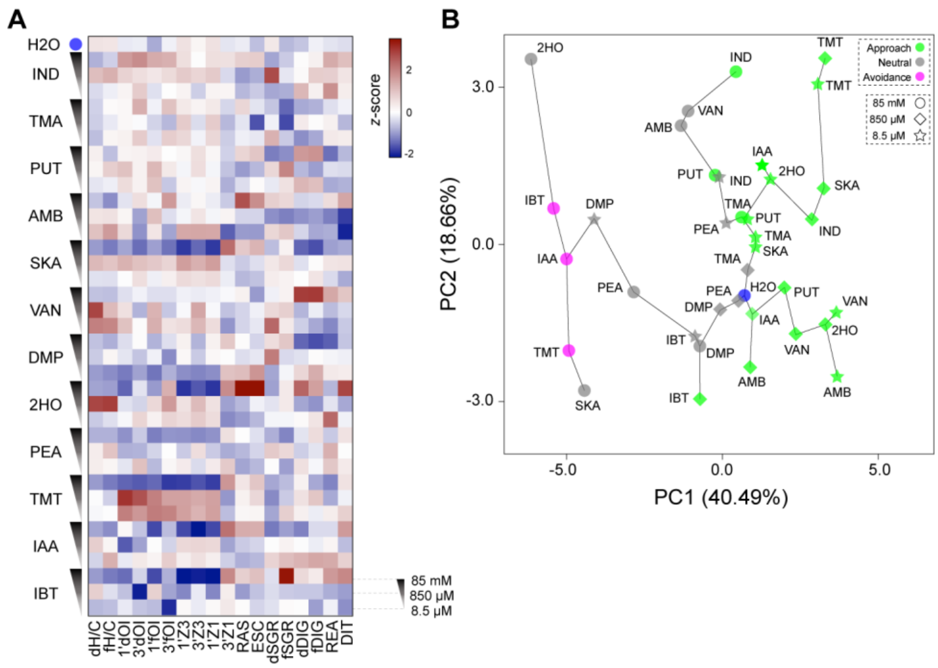

Figure S4. The effect of odorant dosage on behavior, related to Figure 5. (**A**) Heatmap indicating the z-score for each of 12 odorants (relative to all other odorants) for the 18 behavioral parameters measured after exposure to those odorants at three concentrations (85mM, 850µM, and 8.5µM, see STAR Methods). (**B**) Principal component analysis of the behavioral profiles for the 12 odorants tested at the three different concentrations. H_2O is shown in blue, aversive odorants in magenta, neutral in grey, and approached in green. The line connecting the circles indicates the minimum spanning tree. See also Figure 5, and Data S3.

Human parameters	Mean	StDev	Z
Acid	0.048702194	0.07531571	0.646640585
Ammonia	-0.009887358	0.066986152	-0.147603016
Bakery	-0.037669011	0.060638897	-0.621202118
Burnt	-0.121437285	0.076369271	-1.590132828
Chemical	0.039923889	0.071582565	0.557732029
Cold	-0.011707885	0.070135746	-0.166931781
Decayed	-0.023797411	0.081189952	-0.293107834
Fish	0.005314301	0.087729115	0.060576247
Flower	-0.07325992	0.06768923	-1.082298035
Fruit	0.023629055	0.066334428	0.356211031
Garlic	0.102715311	0.085814371	1.196947672
Grass	0.011990264	0.054774955	0.218900474
Intensity	0.058308333	0.059595577	0.97840034
Musky	-0.005165428	0.0783955	-0.065889347
Pleasantness	-0.081756002	0.09275403	-0.881428029
Sour	-0.081562531	0.078791444	-1.035169908
Spices	-0.078923349	0.068496048	-1.152232154
Sweaty	-0.01983751	0.092195631	-0.215167576
Sweet	0.039596144	0.080172095	0.493889353
Warm	0.065088094	0.085555097	0.760774008
Wood	0.054981654	0.060035691	0.915816124

Table S1. Weights of each human perceptual descriptor in the first CCA dimension aligning human perceptual and mouse behavioral spaces, related to Figure 3. The standard deviation is obtained using 100 shuffles of the original data, applying CCA to each, and computing the standard deviation across weights obtained from these shuffles. See also Figures 3, S2, and S3.

SUPPLEMENTAL REFERENCES

S1. Keller, A., and Vosshall, L.B. (2016). Olfactory perception of chemically diverse molecules. BMC neuroscience 17, 55.

S2. Keller, A., Gerkin, R.C., Guan, Y., Dhurandhar, A., Turu, G., Szalai, B., Mainland, J.D., Ihara, Y., Yu, C.W., Wolfinger, R., et al. (2017). Predicting human olfactory perception from chemical features of odor molecules. Science 355, 820-826.