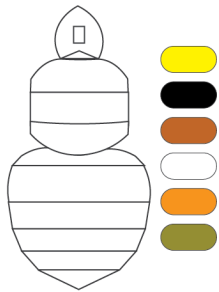


Electronic Supplementary Material for:

Briana D. Ezray, Drew C. Wham, Carrie E. Hill, and Heather M. Hines*. “*Unsupervised machine learning reveals mimicry complexes in bumble bees occur along a perceptual continuum*”, Proceedings of the Royal Society B (DOI: 10.1098/rspb.2019.1501).

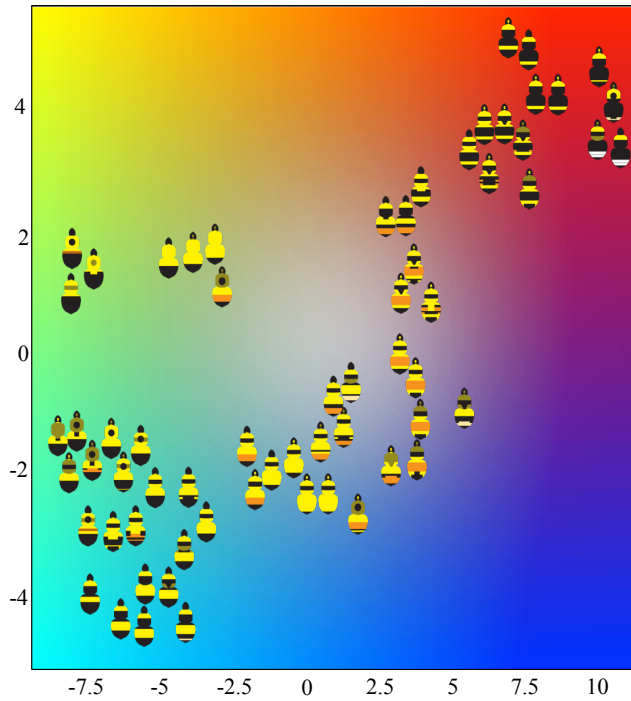
Supplemental Figures:



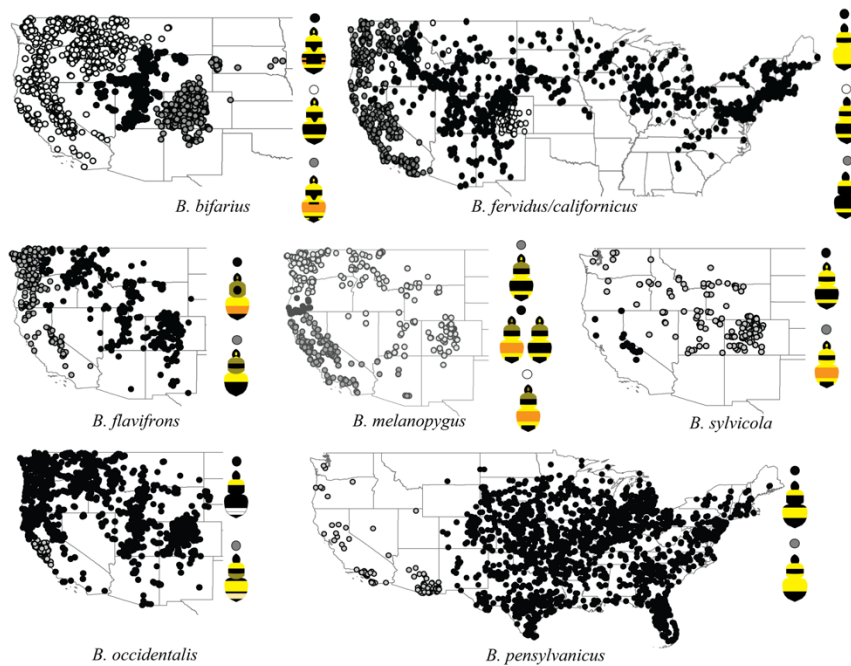
Supplementary Figure 1. Standardised template and colour palette utilised to create bumble bee colour pattern diagrams used in perceptual analyses and displayed in (Fig. 1) and (Supp. Fig. 2).

<i>B. affinis</i> (af)		<i>B. flavifrons</i> (fl)		<i>B. occidentalis/terricola</i> (oc)/(te)	
<i>B. appositus</i> (ap)		<i>B. franklini</i> (fr)		<i>B. pensylvanicus/sonorus</i> (pe)/(so)	
<i>B. auricomus</i> (au)		<i>B. fraternus</i> (fa)		<i>B. perplexus</i> (pr)	
<i>B. balteatus</i> (ba)		<i>B. frigidus</i> (fi)		<i>B. rufocinctus</i> (ru)	
<i>B. bifarius</i> (bf)		<i>B. griseocollis</i> (gr)		<i>B. sandersoni</i> (sn)	
<i>B. bimaculatus</i> (bi)		<i>B. huntii</i> (hu)		<i>B. sitkensis</i> (si)	
<i>B. borealis</i> (bo)		<i>B. impatiens</i> (im)		<i>B. sylvicola</i> (sy)	
<i>B. caliginosus</i> (cl)		<i>B. melanopygus</i> (me)		<i>B. ternarius</i> (tr)	
<i>B. centralis</i> (ce)		<i>B. mixtus</i> (mi)		<i>B. vagans</i> (vg)	
<i>B. crotchii</i> (cr)		<i>B. morrisoni</i> (mo)		<i>B. vandykei</i> (va)	
<i>B. fervidus/californicus</i> (fe)/(ca)		<i>B. nevadensis</i> (ne)		<i>B. vosnesenskii</i> (vo)	

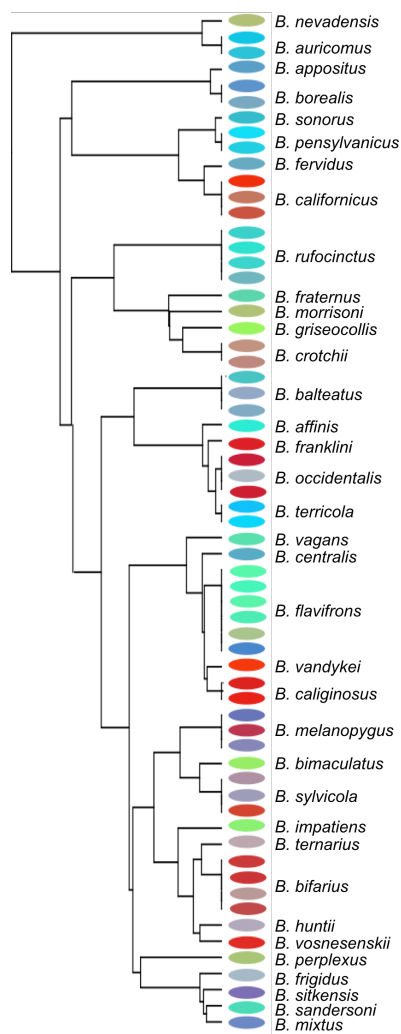
Supplementary Figure 2. Colour pattern diagrams used in perceptual analyses (Figure 1) and their assigned embedded colour code representing the embedding value from the t-SNE analysis by species. Species pairs *B. pensylvanicus*/*B. sonorus* and *B. californicus*/*B. fervidus* were combined for analyses given uncertain colour pattern sorting among sister species [1,2].



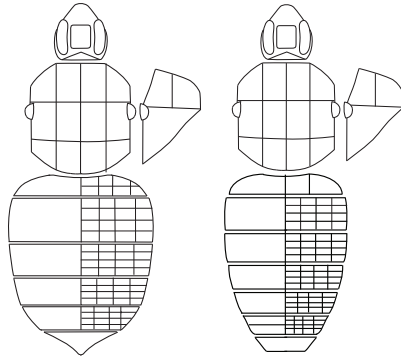
Supplemental Figure 3. The colour wheel utilised to extract the embedded colour code for each x,y coordinate value from the t-SNE plot.



Supplemental Figure 4. Assignment of colour patterns of polymorphic species for analysis of perceptual colour pattern frequencies. Assigned based on literature references of colour distribution (*B. fervidus*: [2]; *B. sylvicola*: [1,3]; *B. occidentalis*: [1,3,4]; *B. pensylvanicus*: [1]; *B. bifarius*: [5]; *B. flavifrons*: [4]) and the data obtained for this study. *B. rufocinctus* was excluded as it is usually rare and often misidentified due to colour pattern variability [1,3].



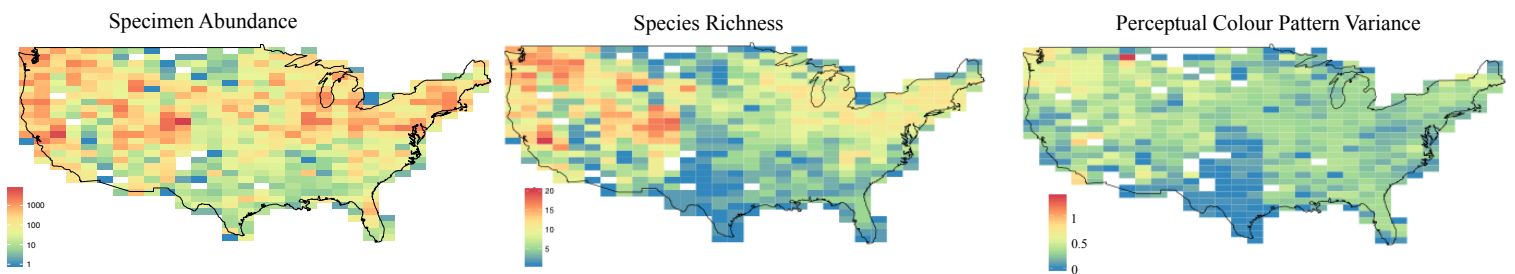
Supplemental Figure 5. Bumble bee phylogeny [6] including each species found in the contiguous United States with embedded colour codes from the t-SNE analysis and species names.



Supplemental Figure 6. Bumble bee templates (female (workers and queens) and male (drones) used to phenotype and quantify colour patterns of *B. flavifrons*, *B. melanopygus*, and *B. bifarius*. Overall percentage of black vs. ferruginous in metasomal tergites 2 and 3 for *B. melanopygus* and *B. bifarius*, and tergite 3 in *B. flavifrons* was used for analyses.



Supplementary Figure 7. Images of polymorphic species, *B. bifarius* and *B. melanopygus*, colour patterns. These images display the continuous spectrum of colour patterns of *B. bifarius* and the discrete nature of colour patterns of *B. melanopygus*.



Supplemental Figure 8. Specimen abundance, species richness, and perceptual colour pattern variance of bumble bee GBIF data [7] utilised in our analyses.

1	annual mean temperature
2	mean diurnal range
3	isothermality
4	temperature seasonality
5	maximum temperature of the warmest month
6	minimum temperature of the coldest month
7	temperature annual range
8	mean temperature of the wettest quarter
9	mean temperature of the driest quarter
10	mean temperature of warmest quarter
11	mean temperature of the coldest quarter
12	annual precipitation
13	precipitation of the wettest month
14	precipitation of the driest month
15	precipitation seasonality
16	precipitation of the wettest quarter
17	precipitation of the driest quarter
18	precipitation of the warmest quarter
19	precipitation of the coldest quarter

Supplemental Table 1. Bioclimatic variables utilized in all MaxEnt climatic niche analyses.

https://doi.org/10.15468/dl.isi6vc
https://doi.org/10.15468/dl.xw49pp
https://doi.org/10.15468/dl.hnh759
https://doi.org/10.15468/dl.zwwqvq
https://doi.org/10.15468/dl.iko7rn
https://doi.org/10.15468/dl.tkrwr2
https://doi.org/10.15468/dl.ylafrb
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https://doi.org/10.15468/dl.gqs5oe
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https://doi.org/10.15468/dl.i4glyr
https://doi.org/10.15468/dl.g0qdhy
https://doi.org/10.15468/dl.eqgpdv
https://doi.org/10.15468/dl.cucaku

Supplemental Table 2. GBIF occurrence download digital object identifiers (DOI) for each species (N=35).

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