Supporting Information for "`pavo`: an R package for the perceptual analysis, visualization and organization of spectral colour data"

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1 Supporting Information

1.1 Exact determination of volume overlap

To validate the exact solution for the multidimensional convex hull overlap used to obtain the color volume overlap implemented in `pavo`, we defined two sets of points in three-dimensional space that defined two cubes, with side lengths of 1.0 and 0.5, respectively. Thus, the volumes of these two cubes are $V_1 = 1^3 = 1$ and $V_2 = 0.5^3 = 0.125$. We then shifted the x coordinates of the smaller cube by 0.4 to make the linear overlap along this axis $x_{overlap} = 0.5 - 0.4 = 0.1$ (Figure S1), giving an overlap volume of $V_3 = 0.1 * 0.5^2 = 0.025$. We then calculated the known proportional overlap volume based on the exclusion-inclusion principle as $p_{overlap} = V_3/(V_2 + (V_1 - V_3)) = .02272727$ (see Figure S1). Finally, we used the `voloverlap` function to estimate the proportional overlap and found that the value calculated by `voloverlap` for this set of points matched exactly (dashed line in S2).

To further show the benefit of an exact versus approximate solution (i.e. using Monte Carlo simulation), we compared the accuracy and precision of the Monte Carlo (MC) method described in Stoddard & Stevens (2011) by running simulations over a range of MC sample sizes (n): 100, 1000, 10000, and 100000. For each n, we repeated the simulation a total of 10 times to estimate confidence intervals and thus evaluate the precision of the estimates. The Monte Carlo method, while eventually converging on the correct solution, requires large sample numbers (and, hence, is more time-intensive) and can overestimate values at low MC sample numbers (see Figure S2).

References

Stoddard, M.C. & Stevens, M. (2011) Avian vision and the evolution of egg color mimicry in the common cuckoo. *Evolution*, **65**(7), 2004–2013.

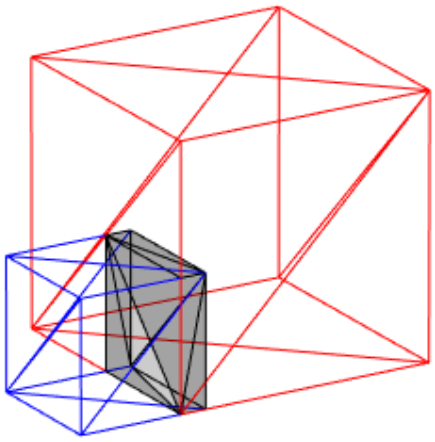

Figure S1: Test geometries for validating `voloverlap`. Red and blue cubes are convex hulls enclosing all points, with overlap region shaded in grey.

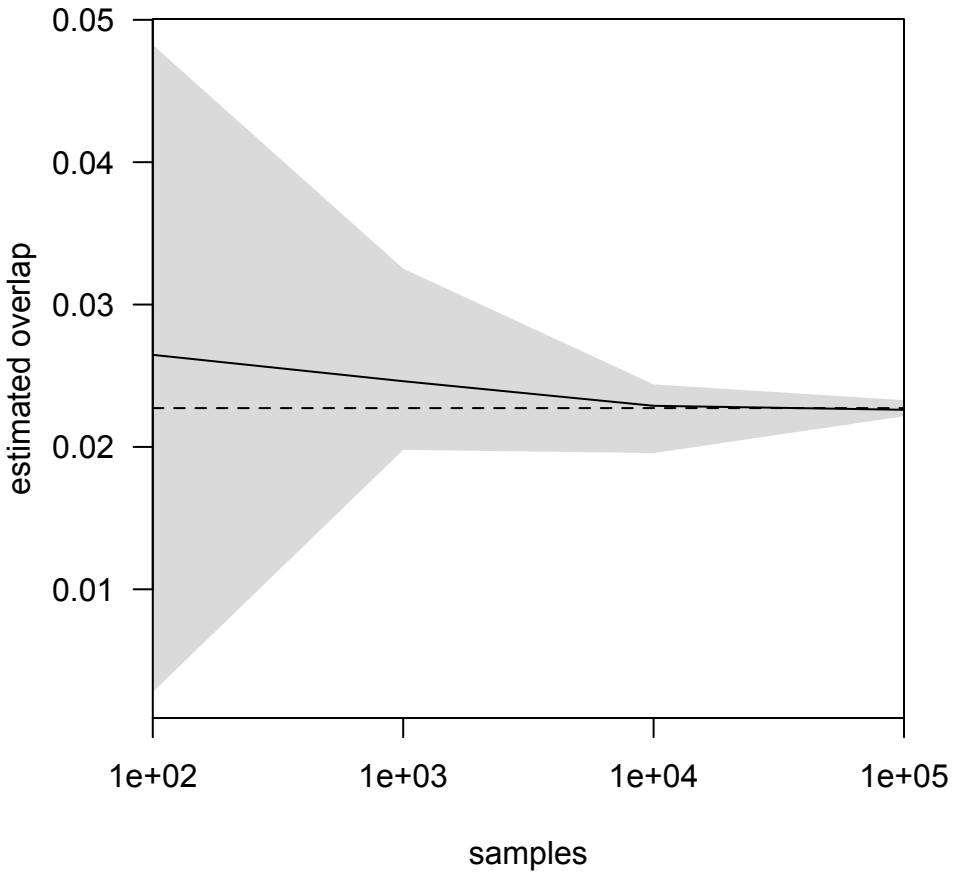

Figure S2: Results of Monte Carlo simulations of volume overlap compared to the exact result. Grey polygon shows 95% confidence interval around estimated mean volume overlap (solid black line). Dashed line indicates true overlap calculated using `voloverlap` in `pavo`.