Seeing red: color vision in the largemouth bass

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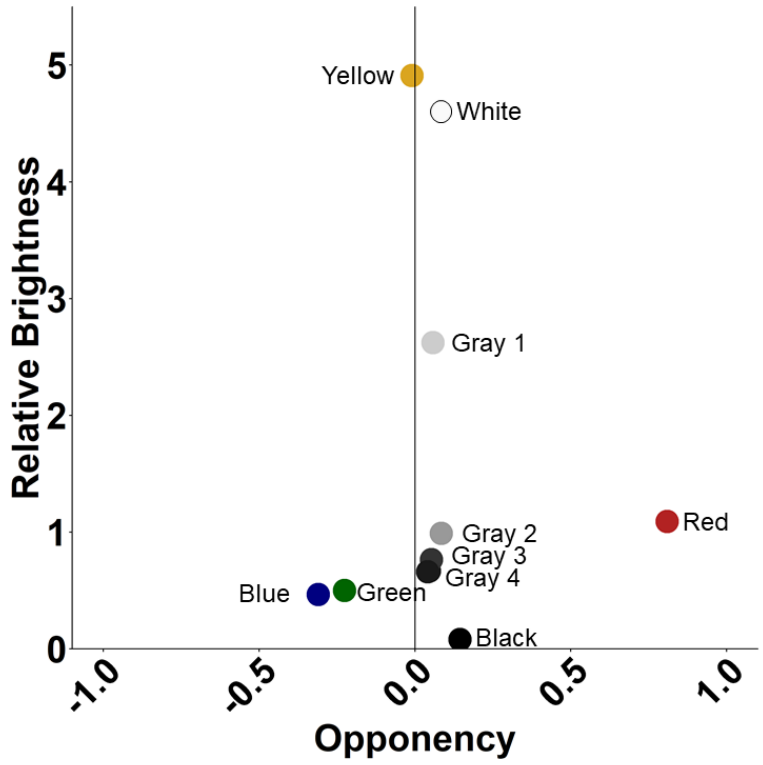
Supplemental Materials

Methods – Brightness

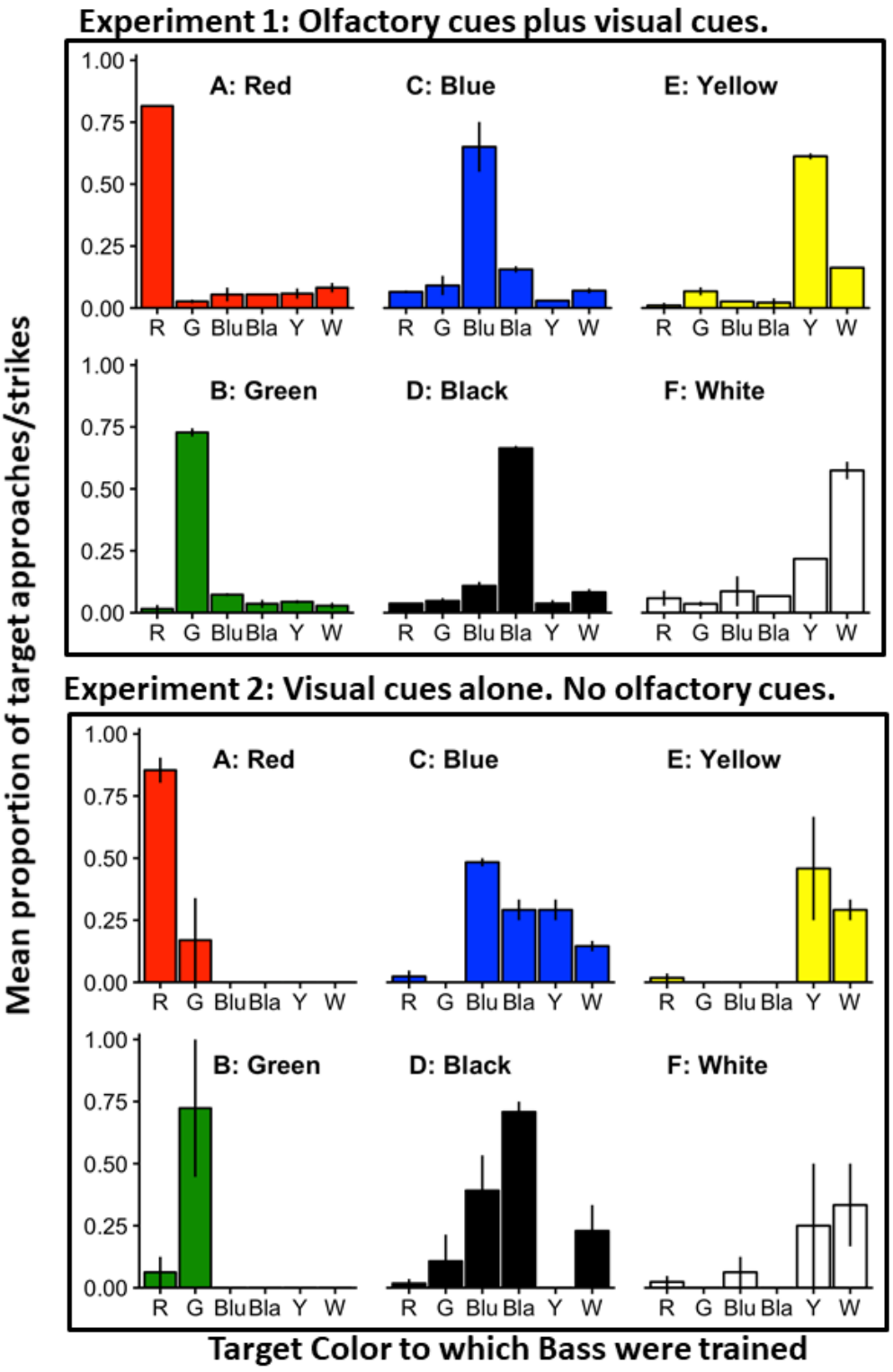
Here, the photon-catch from both the green and red photoreceptors were used to predict the brightness from a given visual stimulus. Relative brightness was calculated as the sum of the photon-catch of the two photoreceptor types and divided by the brightness that would be created by a gray standard that reflects 25% of light from the white standard (B_{25}) (see Baldwin and Johnsen 2012 for similar calculations). Relative brightness (B) was calculated as the following:

$$B = \frac{P_{red,target} + P_{green,target}}{P_{red,gray25} + P_{green,gray25}}$$

where $A_i(\lambda)$ is the diffuse spectral sensitivity of receptor I; λ is wavelength; $E_h(\lambda)$ is side-welling irradiance; and $R(\lambda)$ is the reflectance of the target. Integration was over the visible light spectrum ranging from 350 nm to 700 nm. Opponency was calculated as described in the main manuscript. Supplemental Figure 1 shows the model predictions for opponency and relative brightness assuming that both red and green cones contribute equally to perceived brightness.



Supplemental figure 1. *M. salmoides* visual detection model (relative brightness and opponency of colored cards) using spectral sensitivities from both the green and red cone to assess brightness for training colors (chartreuse yellow, white, red, blue, green, and black) and achromatic stimuli used in assay 3 (white, gray 1, gray 2, gray 3, gray 4, gray 5, and black).



Supplemental figure 2: Average proportion of bass that approached/struck at each pipette color (A-F) as a function of training color (x-axis). Experiment 1: The data show the results of trials where *olfactory cues were present*. Experiment 2: The data show the results of trials when *olfactory cues were absent*. Bars show means ± SE, n=2 for each. A-F indicates pipette color. The x-axis indicates the training color. A = red, B = green, C = blue, D = black, E = yellow, and F = White.

Supplemental Table 1. Mean number of bass who approached and struck each target color during Experiment 1 when *olfactory cues were present*. For each tank, we first calculated the mean number of bass that approached/struck at each pipette across the 70 replicate training days. The table presents the means subsequently calculated across the two replicate tanks for each training color. Units are mean number of bass.

Training Color: olfactory cue present						
Pipette Color	**Black**	**Blue**	**Green**	**Red**	**White**	**Yellow**
White	0.3	0.5	0.3	0.3	4.0	1.6
Black	4.8	0.9	0.4	0.1	0.4	0.2
Red	0.2	0.2	0.3	6.0	0.4	0.3
Blue	1.1	4.7	0.6	0.3	0.5	0.2
Yellow	0.0	0.0	0.3	0.0	1.4	4.1
Green	0.1	0.3	5.0	0.0	0.1	0.2
Total	6.7	6.8	6.9	6.8	6.7	6.6

Supplemental Table 2. Mean count of bass who approached and struck each target color during Experiment 2 when *olfactory cues were absent*. For each tank, we first calculated the mean number of bass that approached/struck at each pipette across the 4 replicate testing days. The table presents the means subsequently calculated across the two replicate tanks for each training color. Units are mean number of bass.

Training Color: olfactory cue absent						
Pipette Color	**Black**	**Blue**	**Green**	**Red**	**White**	**Yellow**
White	0.0	1.2	0.0	0.1	2.3	4.7
Black	5.6	1.7	1.2	0.1	2.3	0.0
Red	0.0	0.0	1.2	5.9	0.0	0.0
Blue	1.4	3.5	0.0	0.1	0.0	2.3
Yellow	0.0	0.0	0.0	0.1	2.3	0.0
Green	0.0	0.0	4.6	0.4	0.0	0.0
Total	7.0	7.5	7.0	6.9	7.0	7.0

Supplemental Table 3. Mean second count for bass (n=8) who approached each target color during Experiment 3. Numbers represent the mean time (seconds) that bass spent in close proximity to their training color and the various gray scale alternatives.

	Training Color	
Pipette Color	**Green**	**Red**
Training Color	3.6	5.1
White	0.9	0.8
Gray 1	0.7	3.8
Gray 2	2.7	0.6
Gray 3	1.6	1.4
Gray 4	0.7	1.5
Gray 5	1.7	0.9
Black	2.7	3.0
Total	14.6	17.0