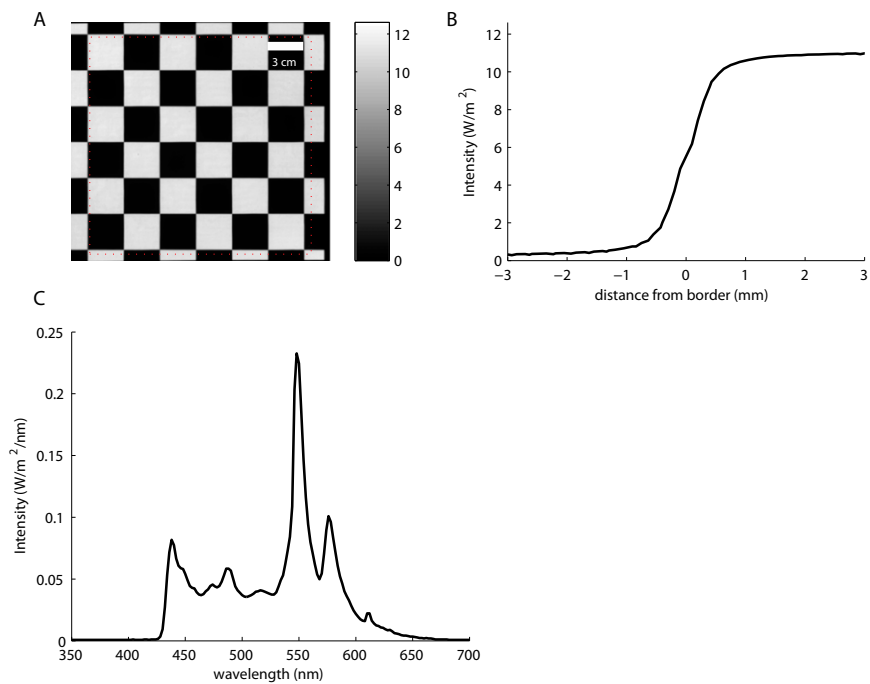
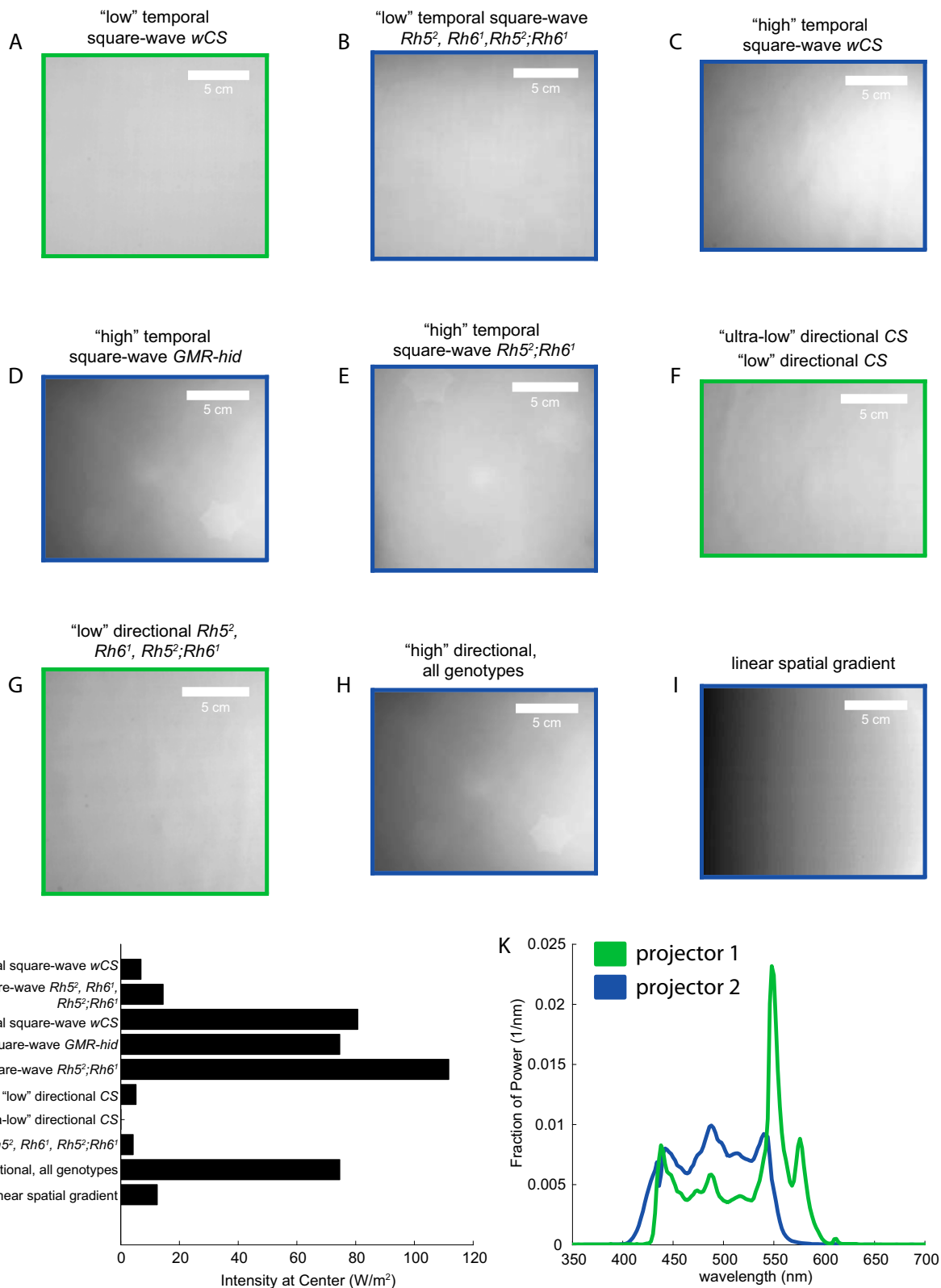


# Supporting Information

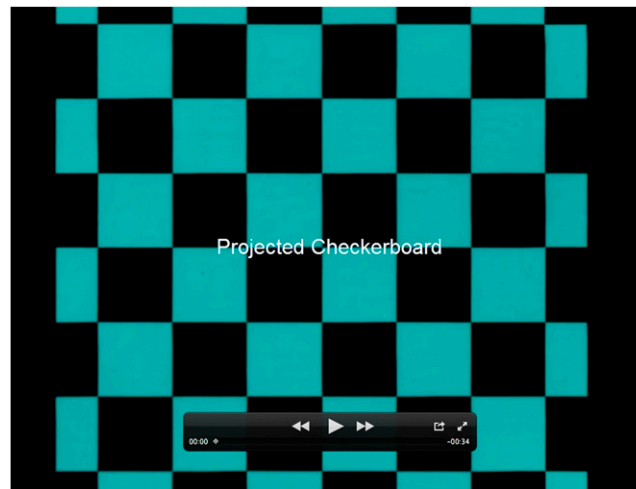
Kane et al. 10.1073/pnas.1215295110



**Fig. S1.** Checkerboard lightscape irradiance (see Fig.1). (A) Irradiance map of the checkerboard lightscape. The red dashed line shows the region where behavior was analyzed. (B) Irradiance vs. distance from checker border (in mm). (C) Spectral irradiance vs. wavelength of projector light.

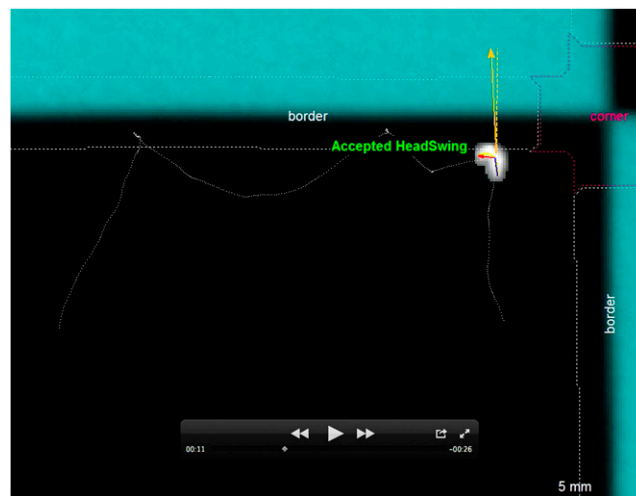


**Fig. S2.** Temporal and directional lightscape irradiance (see Figs. 2 and 3) (A–I) Images of lightscape irradiance used for main figures sorted by experiment and genotype. The colored outline denotes the projector used in the experiment: The green outline indicates projector 1; the blue outline indicates projector 2. (J) Total irradiance at the center of the image for the lightscape depicted in A–I. (K) Spectral irradiance vs. wavelength for projectors.



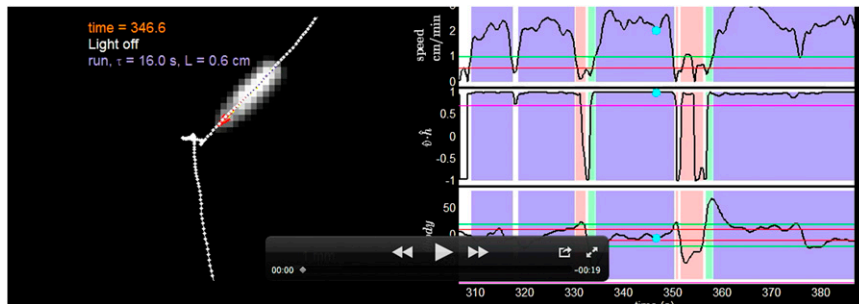
**Movie S1.** Runs and turns taken from a typical experiment on a checkerboard lightscape (experiments depicted in Fig. 1). The movie shows in succession the projected checkerboard pattern (tinted cyan), an infrared image of all larvae being observed, and then a magnified view of a single larva. The track shown is the center-of-mass position of larva over the time period shown. Runs are indicated by orange arrows parallel to the run direction; turns are indicated by green arrows. The squares are 3 cm on a side. (Scale bar, 5 mm.) At 25 frames/s default playback speed, the movie is 5× real time.

#### [Movie S1](#)



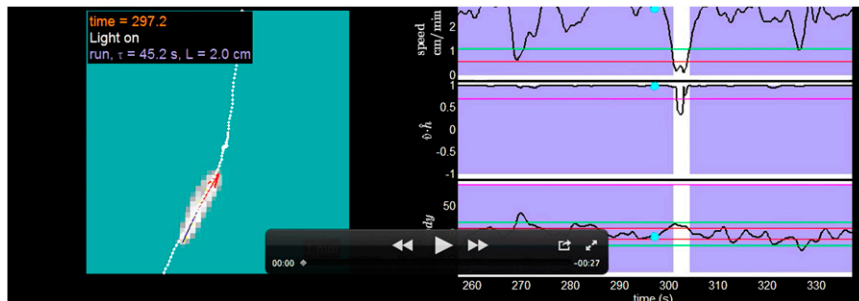
**Movie S2.** Heading relative to boundary, turn direction, and accepted and rejected head-swings on a checkerboard lightscape (experiments depicted in Fig. 1). The movie shows in succession the projected checkerboard pattern (tinted cyan), an infrared image of all larvae being observed, and then a magnified view of a single larva. The track shown is the center-of-mass position of the larva over the time period shown. The border region between two squares is indicated in white; the corner region is indicated in red. (Fig. 1 *D–H* shows the analysis of turns on the border but not on the corner.) Each turn on the border is annotated in sequence with the previous heading relative to the boundary normal (orange  $\theta$ ), whether each head-sweep is accepted or rejected, and the heading change achieved by the turn (green  $\Delta\theta$ ). Squares are 3 cm on a side. (Scale bar, 5 mm.) At 15 frames/s default playback speed, the movie is 3× real time. The movie pauses briefly with each annotation.

#### [Movie S2](#)



**Movie S3.** Light-on-induced turns. The left side shows a section of the larval track (white dots) and a movie of the larva. Yellow dots indicate the midline of the larva, the red arrow is the line from the midpoint to the head, and the blue line runs from the tail to midpoint. The text in upper left corner indicates the time since the beginning of experiment, light status, current behavioral state (run, turn, head-sweep), and the metrics (run duration and distance, turn angle, head-sweep acceptance) of the behavioral state. The cyan background indicates light is on. (Scale bar, 1 mm.) The right side shows the metrics of navigation. In all plots, shading indicates the behavioral state: blue, run; white, turn or pause; red, rejected head-sweep; green, accepted head-sweep. The top plot shows the center-of-mass speed; red and green lines indicate thresholds for ending and beginning a run, respectively. The middle plot shows the dot product between the midhead vector and the velocity vector (1 = head is aligned with the direction of motion; -1 = the larva is backing up). The pink line indicates the threshold for beginning or ending a run. The bottom plot shows the body-bend angle; red and green lines indicate thresholds for ending and beginning a head-sweep, respectively. At 15 frames/s default playback speed, the movie is 3 $\times$  real time.

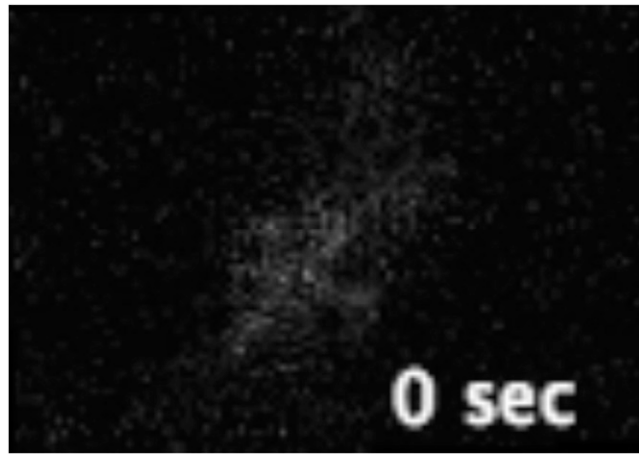
#### [Movie S3](#)



**Movie S4.** Light-off-induced pauses. The left side shows a section of the larval track (white dots) and a movie of the larva. Yellow dots indicate the midline of the larva, the red arrow is the line from the midpoint to head, and the blue line runs from the tail to midpoint. The text in the upper left corner indicates the time since the beginning of the experiment, light status, current behavioral state (run, turn, head-sweep), and metrics (run duration and distance, turn angle, head-sweep acceptance) of the behavioral state. The cyan background indicates the light is on. (Scale bar, 1 mm.) The right side shows the metrics of navigation. In all plots, shading indicates the behavioral state: blue, run; white, turn or pause; red, rejected head-sweep; green, accepted head-sweep. The top plot shows the center-of-mass speed; red and green lines indicate thresholds for ending and beginning a run, respectively. The middle plot shows a dot product between the midhead vector and the velocity vector (1 = head is aligned with direction of motion; -1 = larva is backing up); the pink line indicates the threshold for beginning or ending a run. The bottom blot shows the body bend angle; red and green lines indicate thresholds for ending and beginning a head-sweep, respectively. At 15 frames/s default playback speed, the movie is 5 $\times$  real time.

#### [Movie S4](#)





**Movie S7.** Calcium dynamics of the fifth lateral neuron in response to illumination steps. A movie of the presynaptic region of the fifth lateral neuron in a *tim-Gal4; cry-Gal80* third-instar larva expressing *UAS-GCaMP6*. The movie, taken using a two-photon laser scanning microscope, shows seven 5-s light off/on cycles.

[Movie S7](#)