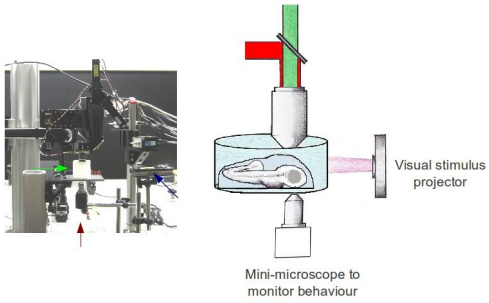
A



B

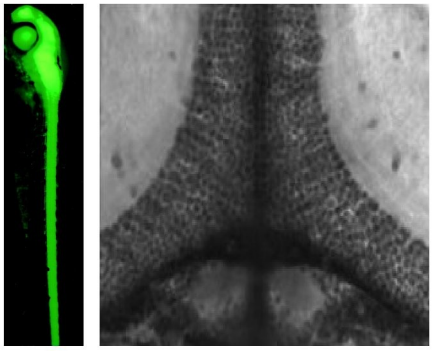
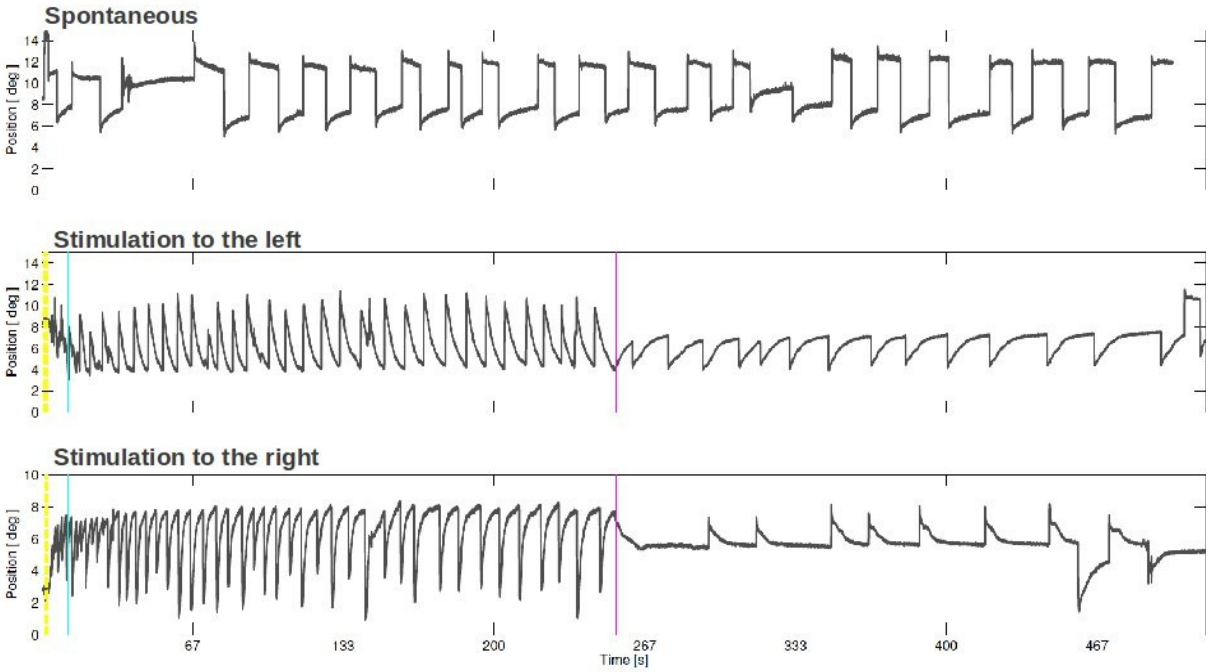


Figure 1. Two-photon calcium imaging of transgenic zebrafish larvae. A) Left: the custom-built two-photon imaging system specially designed for the project, which enables monitoring the activity of large neural circuits in an intact behaving vertebrate. Green arrow: recording chamber with its projection screen. Red arrow: miniature microscope to monitor motor activity. Blue arrow: video projector to present visual stimuli. Right: scheme of the system on the left. B) Left: a transgenic HuC:GCaMP-3 larva. Note the entire nervous system labeled. Right: an optical section of the optic tectum using the system in (A). The neuropil and the periventricular layer (PVL) of the tectum ; and a portion of the cerebellum can be observed. Light scalebar: 500 µm. Right scalebar: 15 µm.

A


Spontaneous
Stimulation to the left
Stimulation to the right
Position [deg]
Time [s]
67
133
200
267
333
400
467

B

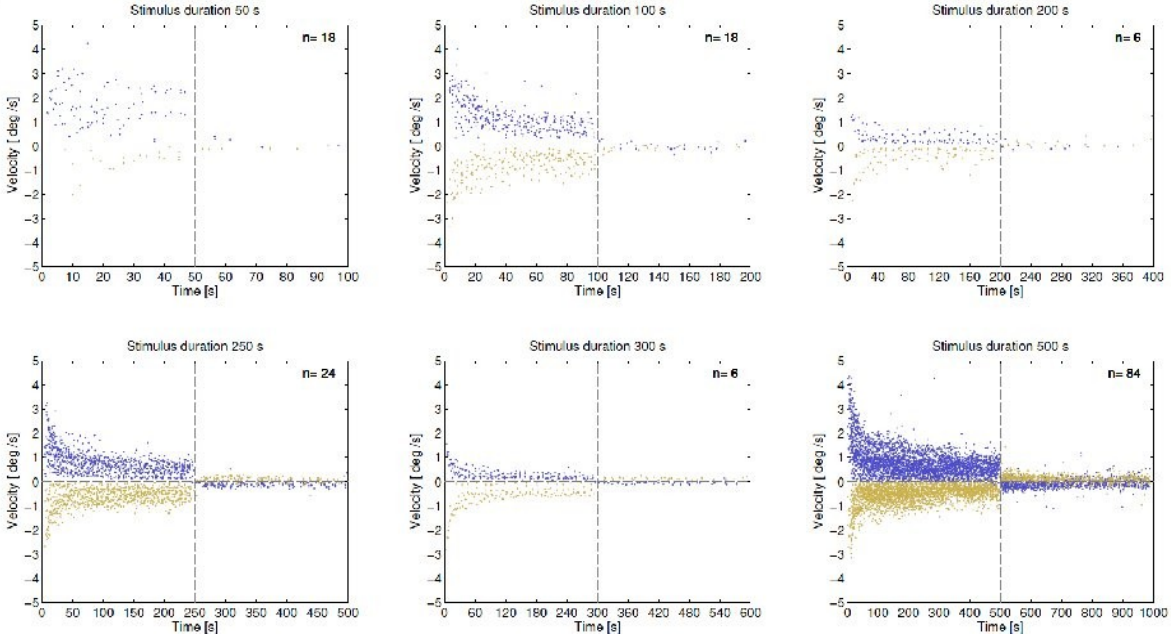

Stimulus duration 50 s
n= 18
Stimulus duration 100 s
n= 18
Stimulus duration 200 s
n= 6
Stimulus duration 250 s
n= 24
Stimulus duration 300 s
n= 6
Stimulus duration 500 s
n= 84
Velocity [deg /s]
Time [s]

Figure 2. Continuous moving visual stimulation induces a motion after-effect illusion (MAE) in zebrafish larvae. A) Top: Spontaneous eye movements in absence of sensory stimulation. Note how the eyes generate rhythmic saccades in one direction followed by a saccade in the opposite direction. Middle: During visual stimulation the larva generates an optokinetic response (OKR), where the eyes slowly follow the direction of the stimulus (pursuits) followed by a saccade in the opposite direction to reset the eye's position. Note that following the end of the stimulation (magenta line) and in absence of sensory stimulation, an inverted OKR is observed, with lower amplitude and frequency. Bottom: Same as above, for a visual stimulus in the opposite direction. B) The velocity of each pursuit eye movement for experiments in which the duration of the stimulus had different lengths. Each point represents the velocity of each pursuits eye movement. Blue: Visual stimulus moved to the right. Yellow: visual stimulus moved to the left. Dash bar: End of stimulation. Duration of the stimulus is noted at the top of each graph. Note how clear inverted pursuits appear following the stimulation, when the latter was longer than ~300 secs.

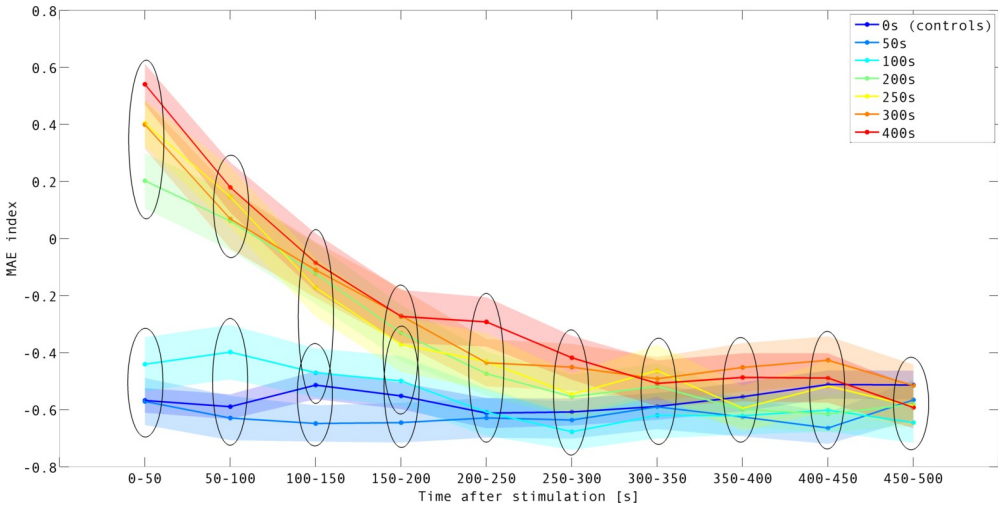


Figure 3. MAE is induce by CS of at least 200 secs and lasts for 150-200 secs.
The colored curves depict the *MAE index* for CS of 0 to 400 secs, at different time points following the end of the CS (0-500 secs) with bins of 50 secs. Note the significant differences at 50, 100 and 150 sec bins for the 250, 300 and 400 secs CS durations (significance indicated by the elipses).

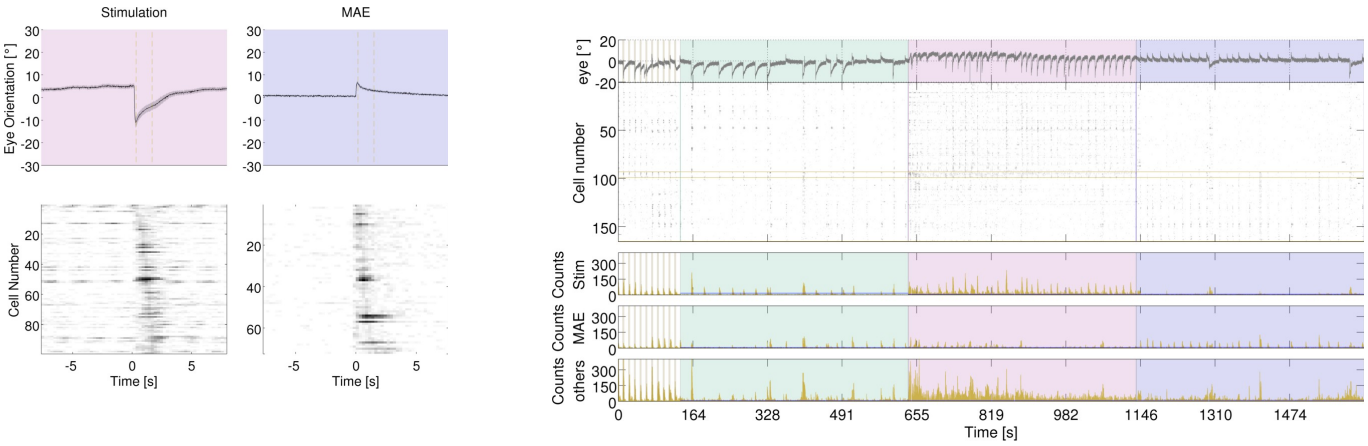


Figure 4. Neuronal activities associated with MAE pursuit movements are a subpopulation of the direction selective responding to the direction of the illusion. Left top, the average kinematics of saccade-pursuit movements during the conditioning stimulus and during MAE. Left bottom, the average neural responses associated to the eye movements on top. Right, example with eye kinematics on top, the raster plot of the recorded neural activities, middle, and histograms of the neural events classified according to the neural directional response (CS direction, MAE direction, non-selective). Note that the cells responsive during the MAE are silent during the CS and respond only to the direction of the expected MAE.