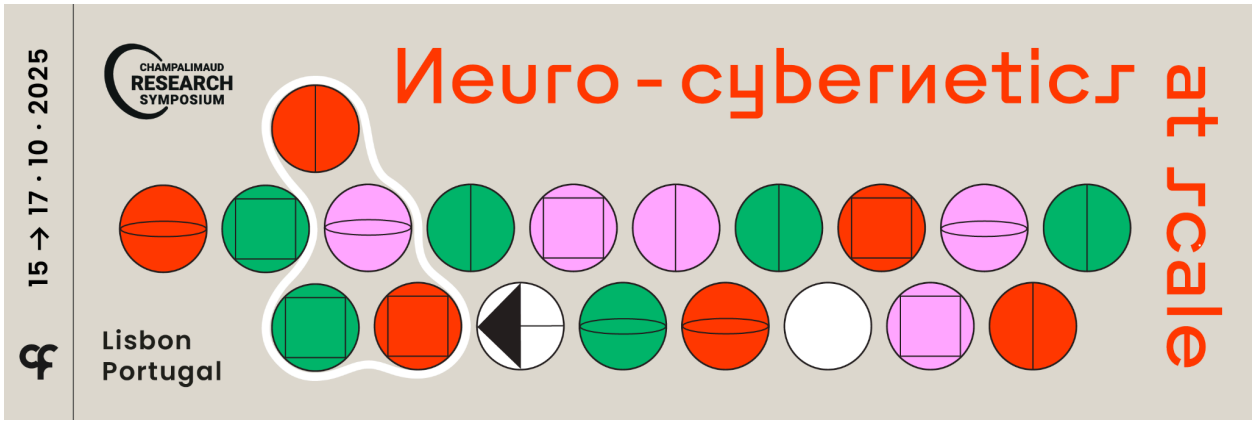

The heading change of a preceding movement predicts the escape bias in larval zebrafish.

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To navigate the environment, an animal must know where it is heading. Recent studies have identified a heading direction system in larval zebrafish, whose circuit architecture resembles the fly's central complex. This suggests that zebrafish, like other animals, might use heading information to guide their movements and decisions. However, no behavior has yet been found in larval zebrafish that depends on heading information—supporting the idea that, although they possess a functional heading system, they don't actually use it.
In this study we challenge this idea by using high speed behavioral tracking and automated movement classification in one week old zebrafish doing the acoustic startle behavior. At this age larvae cannot know the sound location and respond to it by doing escapes to the left or right that seem to be unbiased. These escapes fall into two types: long latency C-starts (LLCs) and short latency C-starts (SLCs). We then asked if the heading change of the previous movement modulates the direction of the escape. Our results show that the direction of the immediately preceding swim defines the direction of both LLC and SLC escapes. This effect varied by escape type. LLCs exhibited a strong tendency to repeat the direction of the previous bout, regardless of its angular magnitude. Surprisingly, SLCs showed a graded modulation dependent on the heading angle of the prior movement which wrapped around for angles larger than 180 degrees. Relying on the prior movement heading to guide the escape direction may be a simple mechanism to allow the animal to rapidly escape in a direction consistent with an ongoing goal. Our findings provide the first behavioral evidence that larval zebrafish use head-direction information to guide behavior and open the possibility of studying the neural mechanisms that support this ability.

Heading direction, navigation, larval zebrafish, acoustic startle, C-starts