1 Structure and equations

take home messages: we do not need the smoothening with von Mises functions to get accurate integration; this can be achieved with 8 discrete EPG neurons. The real connectivity also includes neighboring connections which could also be implemented.

What is PEG-EPG connectivity if there is any? Gap junctions, via PEN2s?

$$f(x) = tanh(x) \tag{1}$$

$$\tau_{EPG}\frac{dEPG}{dt} = -EPG + f(W_{PEG,EPG} \cdot PEG + W_{PEN1_L,EPG} \cdot PEN1_L + W_{PEN1_R,EPG} \cdot PEN1_R + W_{EPG,EPG} \cdot EPG) \tag{2}$$

$$\tau_{PEG}\frac{dPEG}{dt} = -PEG + f(W_{EPG,PEG} \cdot EPG - W_{D7,PEG} \cdot D7) \tag{3}$$

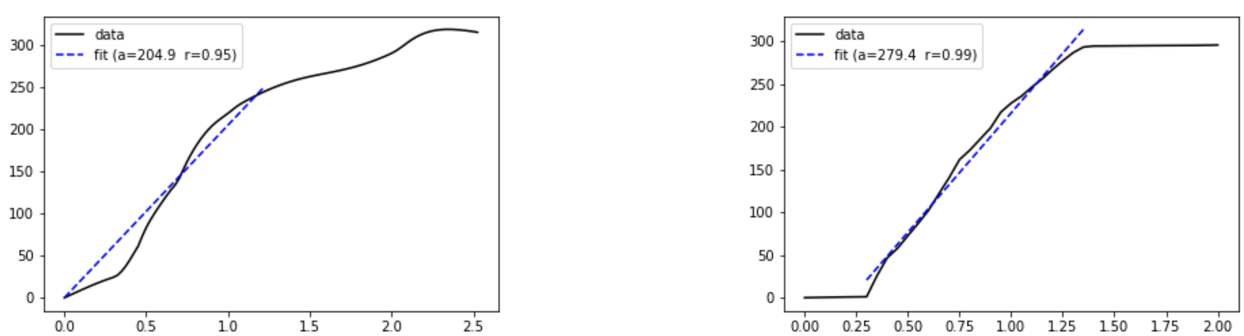
$$\tau_{D7}\frac{dD7}{dt} = -D7 + f(W_{EPG,D7} \cdot EPG) \tag{4}$$

$$\tau_{PEN1}\frac{dPEN1_L}{dt} = -PEN1_L + f(W_{EPG,PEN1_L} \cdot EPG - W_{D7,PEN1_L} \cdot D7 + v_L) \tag{5}$$

$$\tau_{PEN1}\frac{dPEN1_R}{dt} = -PEN1_R + f(W_{EPG,PEN1_R} \cdot EPG - W_{D7,PEN1_R} \cdot D7 + v_R) \tag{6}$$

constraining all firing rates to be positive.

2 Integrating velocities



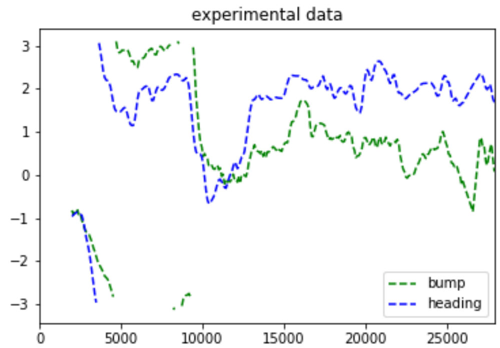
(a) equilibrate for 1000 ms, measure mean veocity over 500 ms -¿ early velocity

(b) For small input, turning is not sustained. Can instead equilibrate for 1000ms, run for 9000 ms.

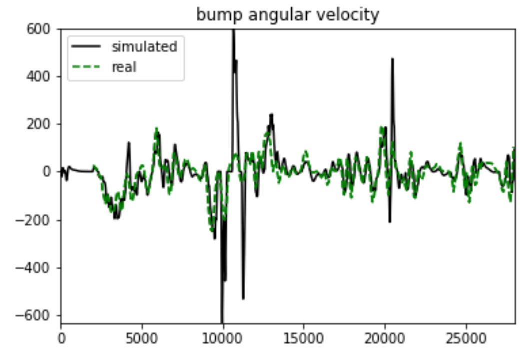
Figure 1

1. equilibrate for 1000 ms, measure mean veocity over 500 ms - early velocity

2. at low angular velocities, this does not lead to a full bump shift and turning is not sustained -¿ mean velocity at later period



(a) real heading and bump position



(b) real and simulated velocity curves

Figure 2

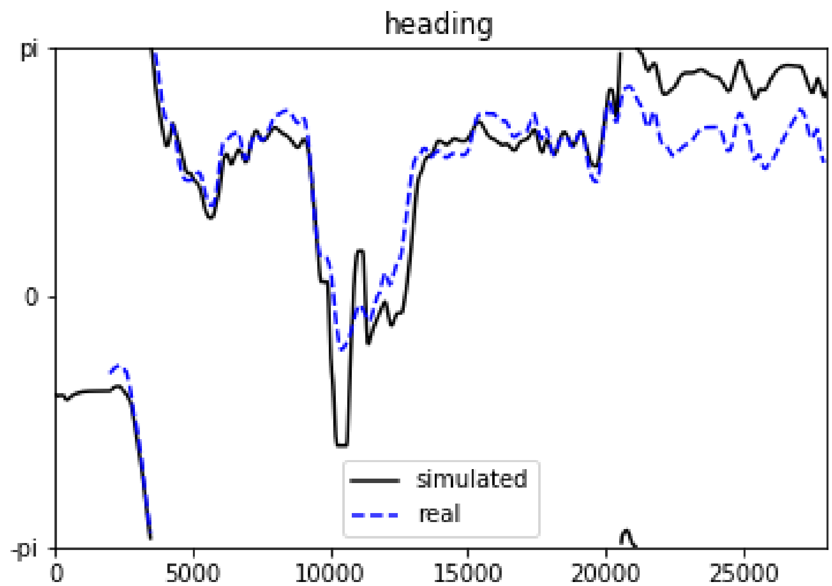
3 tracking experimental data

We see that our integrator does not quite follow the long rapid turn; but neither does the real bump (right) which actually does a worse job recovering from the turn.

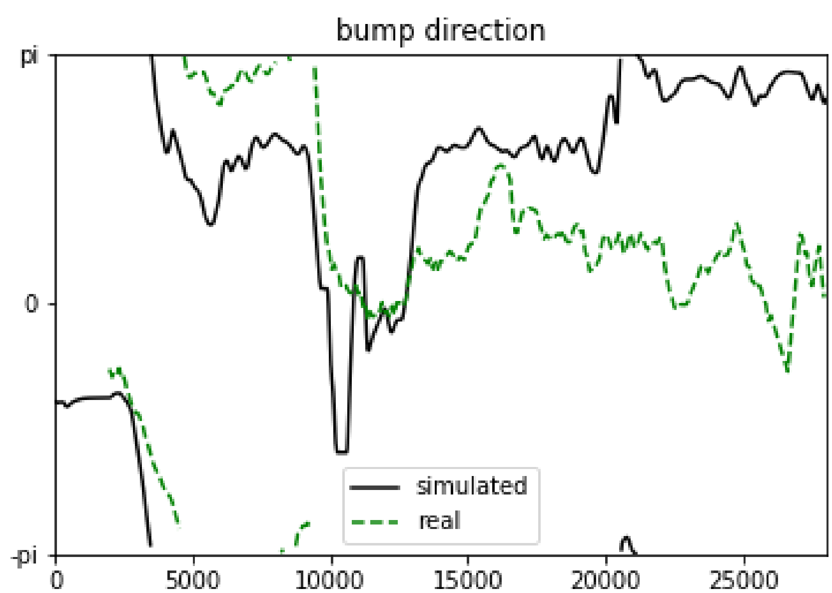
The poor performance can result from very rapid turns leading to strong global PEN1 and thus EPG excitation, which in turn mediates D7 excitation and global inhibition. Thus broad excitation leads to downstream global inhibition and quenching of the bump. This is different from the real system where the bump intensity tends to correlate positively with rotational velocity... Local recurrence EPG - EPG in the EB helos prevent this by retaining activity during strong inhibition of PEN1 and PEG.

Also note intensity and magnitude oscillates at steady state - do we observe this in the data? general feature that dynamical systems can react to changes faster than static systems (metabolism, tennis serve etc...)

4 Simulating shibire experiments

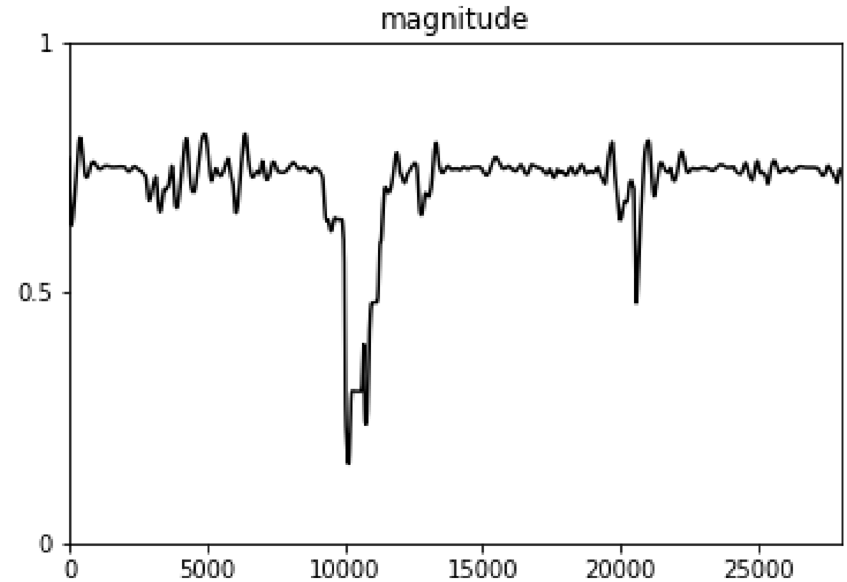


(a) real heading and simulated bump

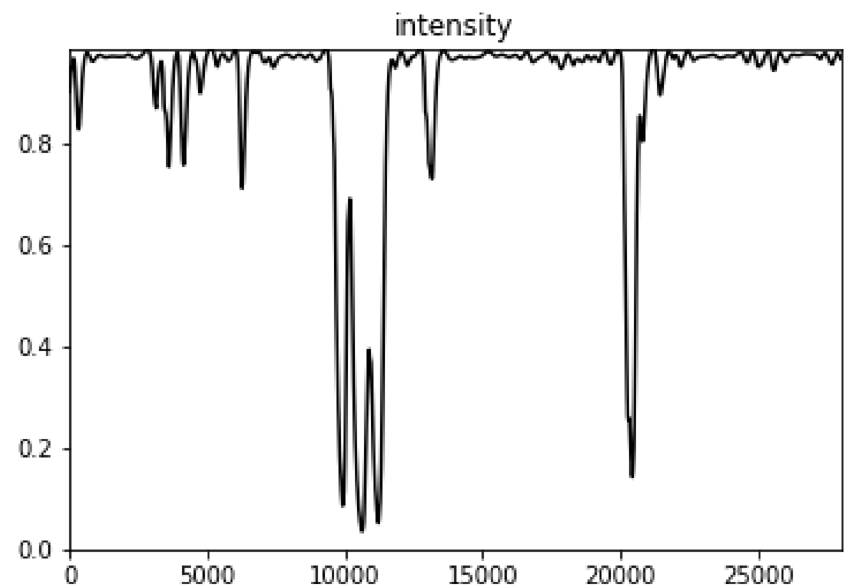


(b) real bump and simulated bump

Figure 3

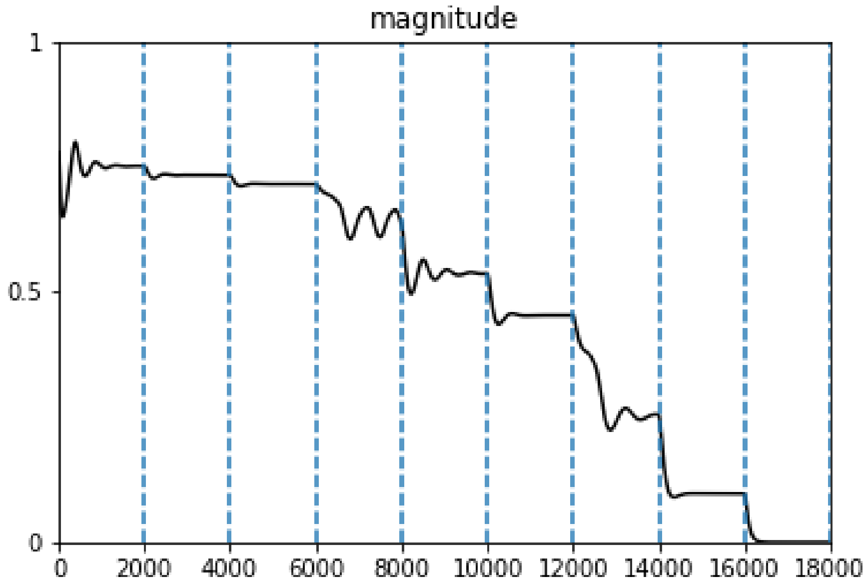


(a) magnitude of PVA average. This decreases strongly near the rapid turn at 10000 ms



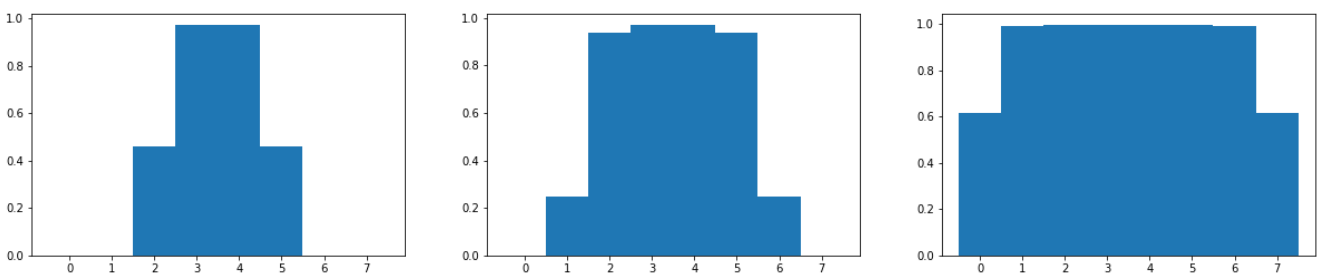
(b) intensity of the most active EPG neuron (bump height). This decreases strongly following global inhibition near the rapid turn at 1000 ms.

Figure 4



(a) magnitude of PVA average for sequential shibire inhition (0, 10%, 20%, ...).

Figure 5

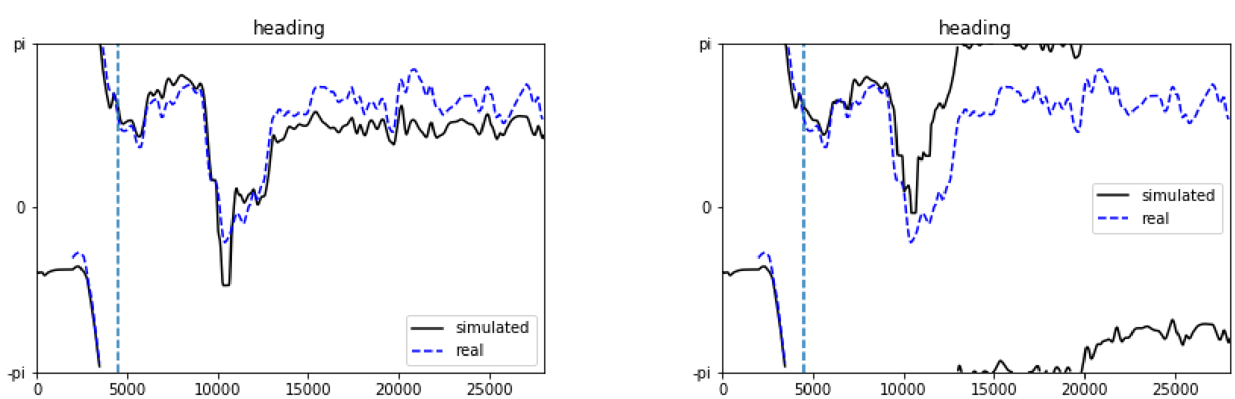


(a) No inhibition

(b) 30% inhibition

(c) 70% inhibition

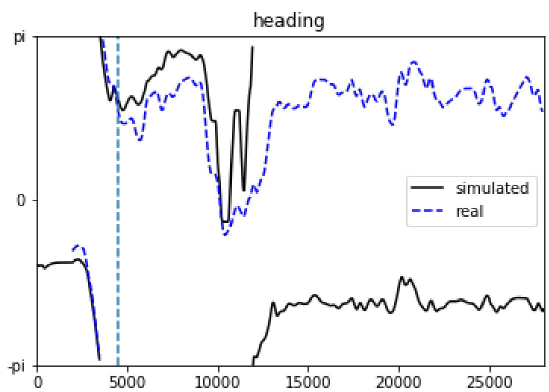
Figure 6



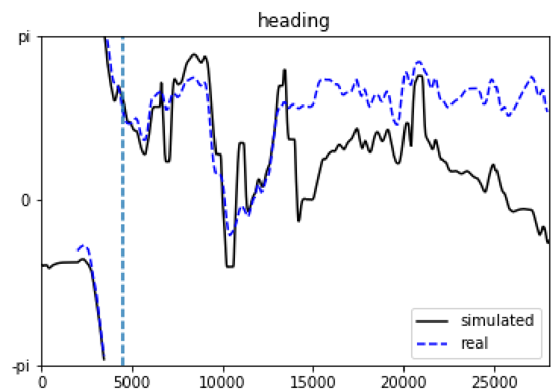
(a) 30% inhibition

(b) 60% inhibition

Figure 7: vertical line indicates time of inhibition.



(a) 30% inhibition PEN1



(b) 30% inhibition PEG

Figure 8: vertical line indicates time of inhibition.