Agar masks locomotion related phenotypes

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Swimming and Crawling

- *C. elegans* locomotion is typically studied on agar, where "crawling" is conventionally associated with a characteristic waveform.
- We demonstrated that crawling and swimming are **not** distinct modes of locomotion. Rather, there exists a continuum of behaviors of which swimming and crawling are two examples [1].
- Therefore a single mechanism must account for the entire range of behaviors.

The agar groove

- When *C. elegans* crawls on agar, it leaves a visible sinuous track, or groove.
- The groove resists sideways motion much more strongly than forwards/backwards motion.
- It has been suggested [2,3] that this groove has functional significance.
- However, we have shown (Fig. 1A) that the worm can "crawl" on a groove-free surface [1], although it doesn't make any progress.

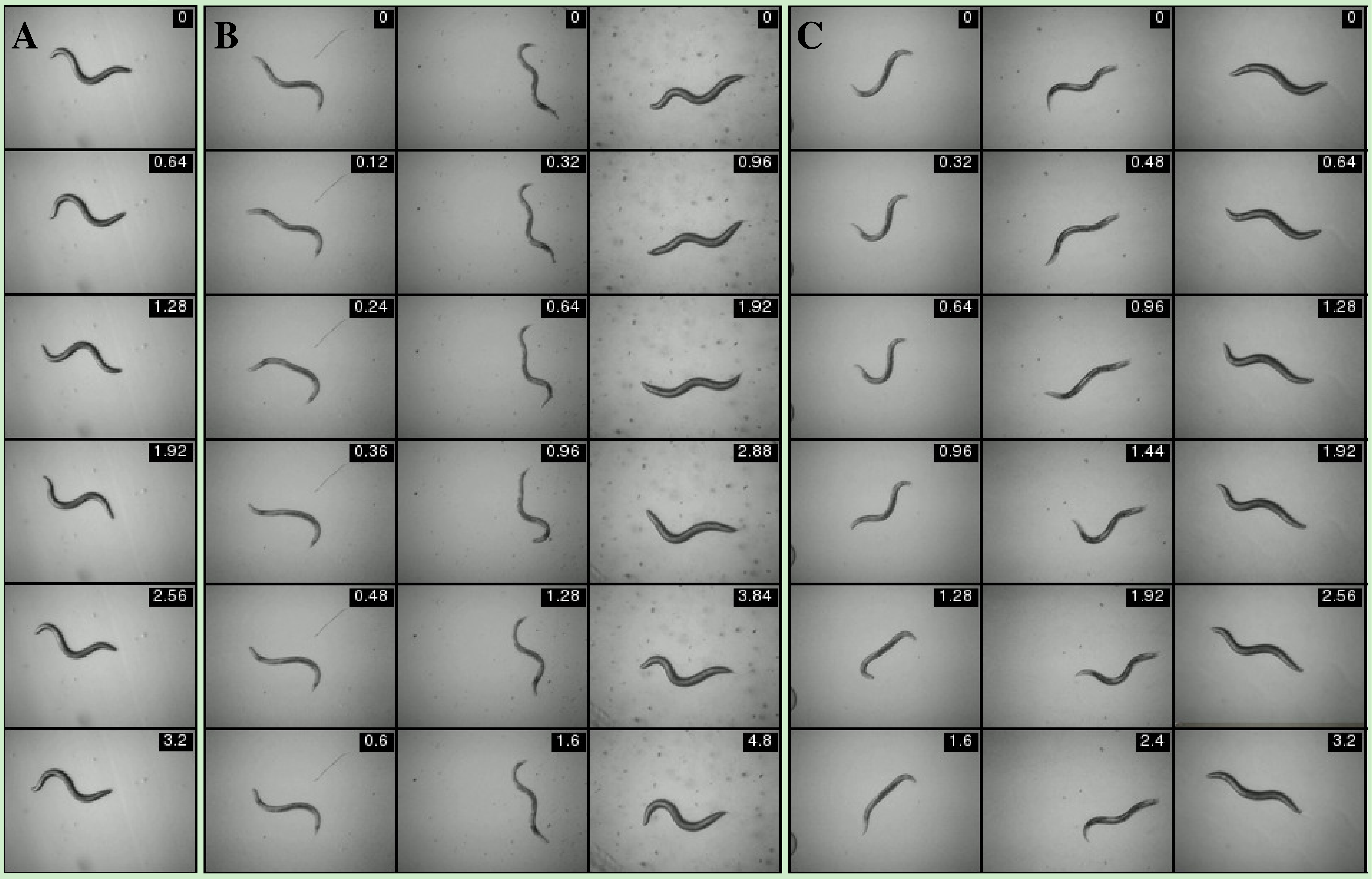

Figure 1. A: Wild type (N2) worms can "crawl" on a flat surface. **B & C:** *unc-8(e49)* and *vab-7(e1562)* worms have only subtle locomotion phenotypes on agar but are almost completely incapable of locomotion in water. Labels show time in seconds.

Model: paralyzed tail

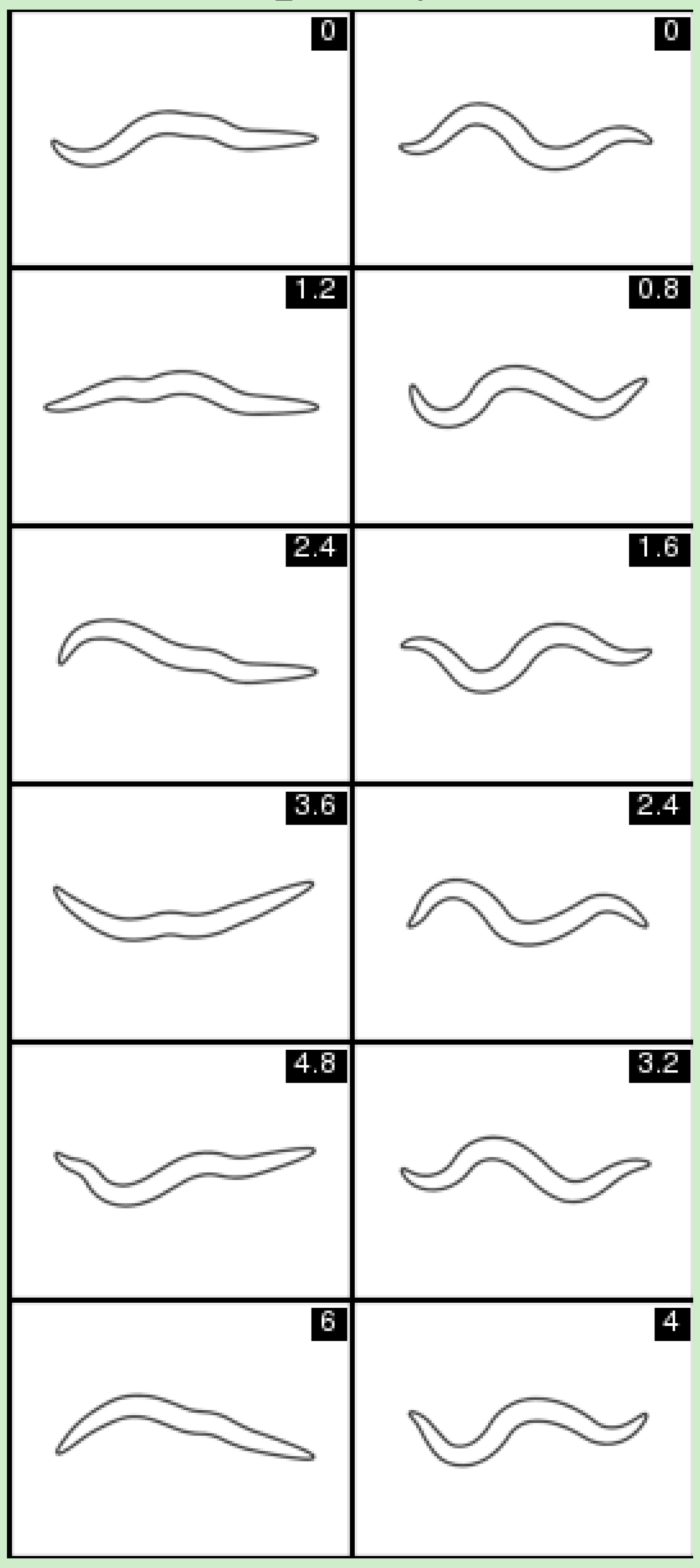

Figure 2. An integrated model of *C.elegans* locomotion (see talk 183, Saturday). Simulation of a worm where the posterior ¼ of the body is paralyzed. Uncoordination is much more evident in water than on agar

unc-30

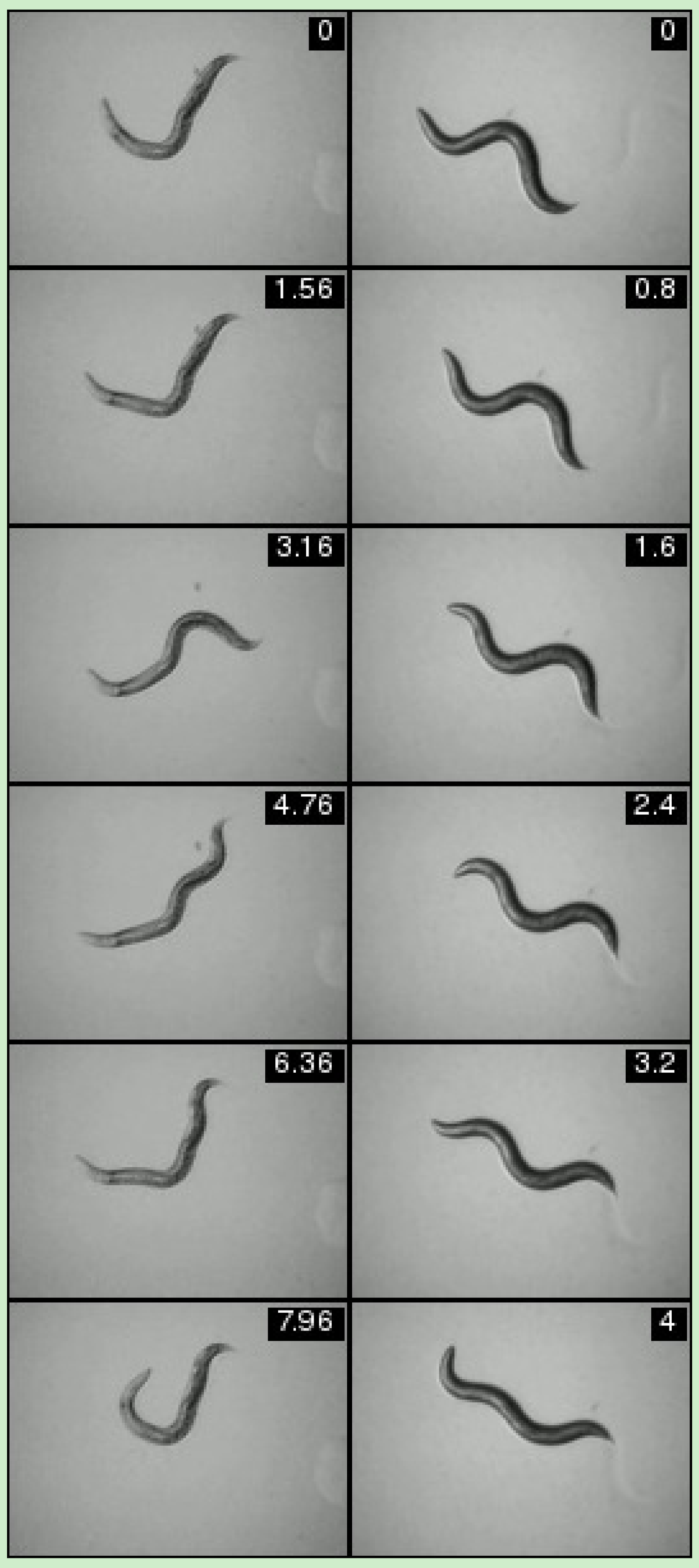

Figure 3. GABA mutants have nearly wild type locomotion on agar but are severely uncoordinated in water.

Agar supports locomotion

- We recorded locomotion-related mutants moving in a range of media with increasing visco-elasticity (from water to agar-like conditions).
- We find that mutant phenotypes can become less severe with increasing stiffness of the medium.
- Specifically, *unc-8(e49)* and *vab-7(e1562)* worms look nearly wild type on agar but are highly defective in water where the posterior body usually fails to oscillate (Fig1B-C).
- The phenotypes have intermediate severity in intermediate media.

Modeling the masking effect

- We recently developed an integrated neural and physical model of *C. elegans* locomotion that accounts for the swim-crawl transition [4] .
- The model relies on proprioceptive stretch receptors to coordinate the neural pattern generation.
- Within this model, we paralyzed the posterior ¼ of the body and simulated the locomotion in different environments (Fig. 2).
- On virtual agar the locomotion is nearly wild type, whereas in water it is severely uncoordinated.
- The agar allows the tail to follow the body, maintaining the sinuous trajectory carved by the head.
- The shape provides the correct sensory input to the rest of the body, facilitating seemingly wild type locomotion.

Agar can mask defects in locomotion screens!

- Agar helps to support coordinated locomotion, but a range of underlying defects can be revealed in water.
- Water screens can identify novel phenotypes. For example, GABA mutants (see unc-30, Fig. 3) suggest novel role for D-type neurons in forward locomotion.
- When screening for locomotion phenotypes, it is advisable to use water in addition to agar.

References

[1] Berri et al. (2009) HFSP J. **3**, 186-193.
[2] Gray and Lissmann (1964) J. Exp. Biol. **41**, 135-154.
[3] Niebur and Erdös (1991) Biophys. J. **60**, 1132-1146.
[4] Boyle et al. (2009) to be submitted; Abstract 183.

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