



Compensating for effects of autotomy on locomotion in stink bugs (*Halyomorpha halys*)

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Research Question: Do insects possess neural plasticity to learn new locomotor patterns after autotomy of a limb?

- Autotomy - the voluntary release of an appendage as a predation defense

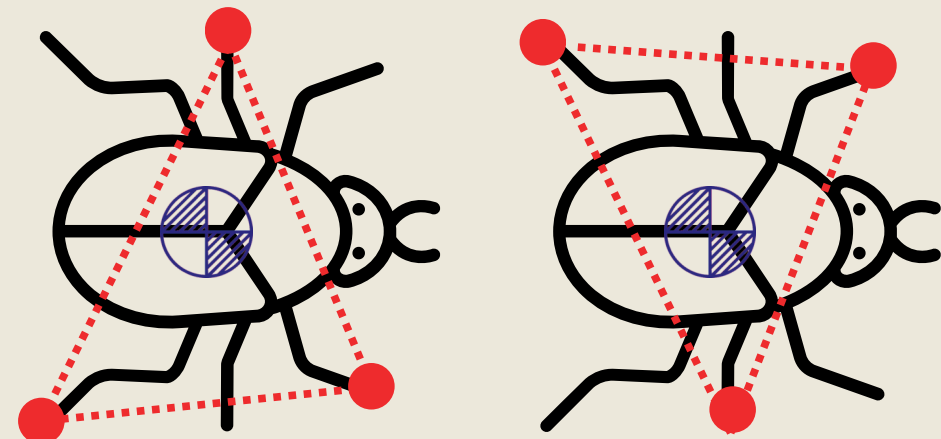
Background Information

Behind the Research Question

Insect nervous systems that control leg movement are considered to be too simple to be capable of neural plasticity. However, if autotomy is common enough, and if the locomotor costs of losing a leg in a reproductive adult are significant, we might expect some ability to compensate for leg loss. One obvious area for compensation would be to use neural plasticity to modify gait patterns to optimize stability, efficiency, or speed after autotomy. Autotomy has not, to our knowledge, been used as an extreme disturbance in order to analyze neural plasticity in insects.

Insect Locomotion

- Intact insects use a tripod gait, alternating between two 3-legged stances
- Motor stimulation of legs is passed from front to back, therefore, autotomy on front legs should cause a larger disturbance in locomotion



Tripod gait phases. Red dots represent legs in contact with the ground. The polygon of support (shown with red lines) is formed by the legs in contact with the ground. For intact individuals, the center of mass (COM) is well within the support polygon, indicating high stability.

Objective

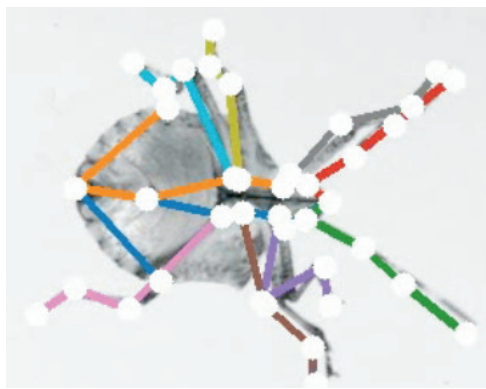
Use autotomy (an extreme disturbance to locomotion) as a method to analyze neural plasticity in insects.

Hypothesis

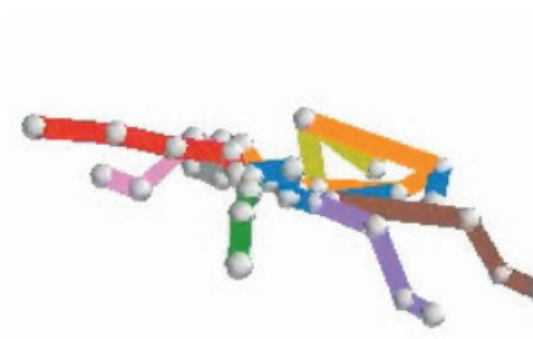
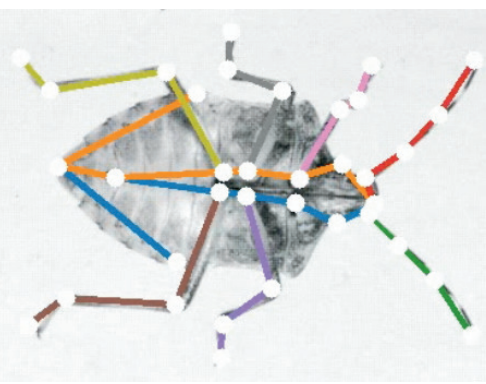
Stink bugs will compensate for the loss of stability caused by autotomy of a front leg by modifying gait patterns via neural plasticity

Methodology

Bugs filmed with two cameras, 32 body parts tracked with Deeplabcut in each camera, and 3D reconstruction performed in Anipose to take measurements

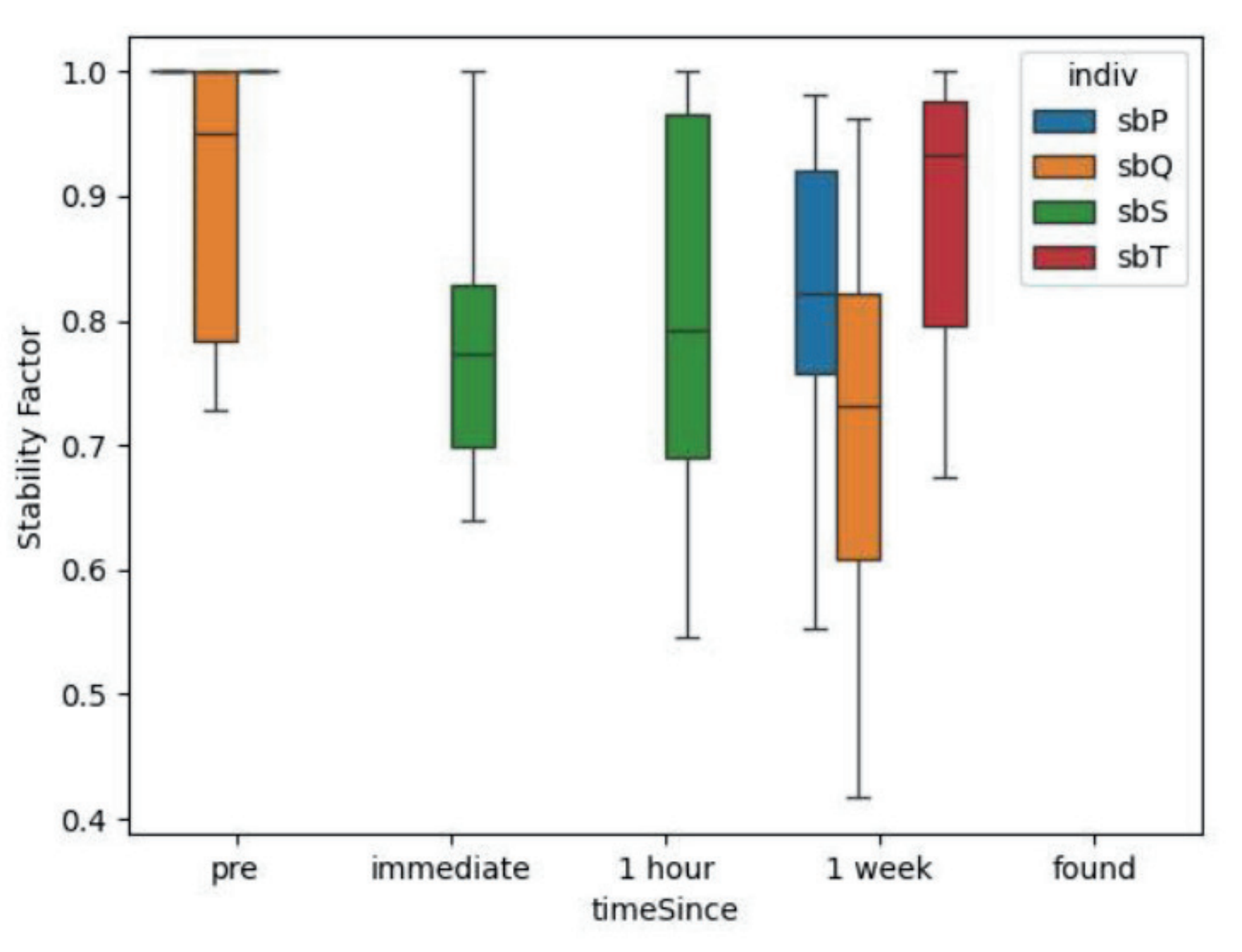


Pre-autotomy tracking and 3D rendering

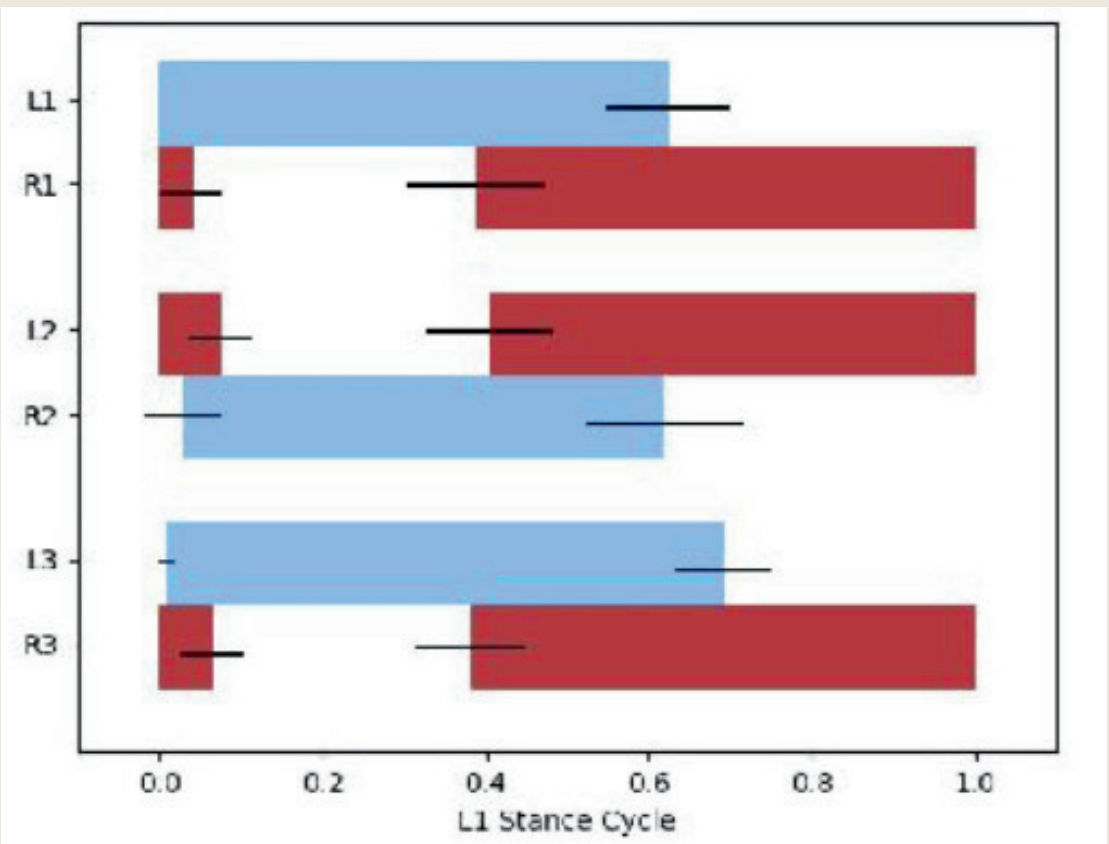


Post-autotomy tracking and 3D rendering

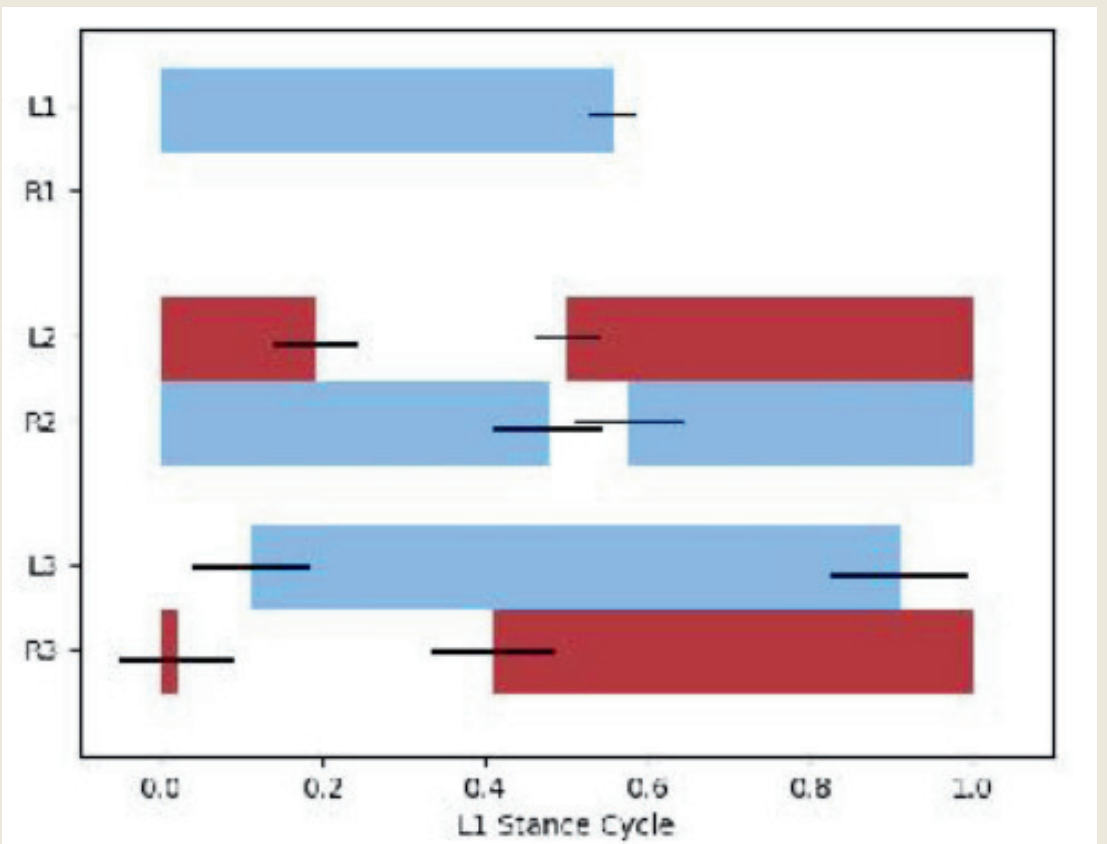
Results



Stability factor (percent of stride with COM over support polygon) decreases with autotomy, but doesn't improve with time based on these results



Pre-autotomy gait cycle



Immediately after autotomy gait cycle

Conclusion

Issues with 3D calibrations are currently limiting the analyzable data. Other than stability, autotomy surprisingly did not have much impact on walking speed or other kinematic measures. Variability in most measures increases after autotomy while stability decreases. Currently, with this preliminary data set, we cannot determine if they learn to compensate or not because of the increase in variability, variability between individuals, and current lack of good data across a full series.

References

Domínguez M, et al. 2016. Losing legs and walking hard: effects of autotomy and different substrates in the locomotion of harvestmen in the genus *Prionostemma*. *JoA*.
Escalante I, et al. 2020. Rapid recovery of locomotor performance after leg loss in harvestmen. *Sci Rep*.
Fleming PA, Bateman PW. 2007. Just drop it and run: the effect of limb autotomy on running distance and locomotion energetics of field crickets (*Gryllus bimaculatus*). *J Exp Biol*.
Guffey C. 1999. Costs associated with leg autotomy in the harvestmen *Leiobunum nigripes* and *Leiobunum vittatum* (Arachnida: Opiliones). *Can J Zool*.
Wilshin S, et al. 2018. Limping following limb loss increases locomotor stability. *J Exp Biol*.
Arnold SJ. 1983. Morphology, Performance and Fitness. *Am Zool*.
Graham D. 1977. The effect of amputation and leg restraint on the free walking coordination of the stick insect *Carausius morosus*. *J Comp Physiol*.
Hughes GM. 1952. The Co-Ordination of Insect Movements: I The Walking Movements of Insects. *J Exp Biol*.
Karashchuk, et al. 2021. Anipose: A toolkit for robust markerless 3D pose estimation. *Cell Rep*.
Nath T, et al. 2019. Using DeepLabCut for 3D markerless pose estimation across species and behaviors. *Nat Protoc*.