Effect of travel effort on movement vigor during foraging

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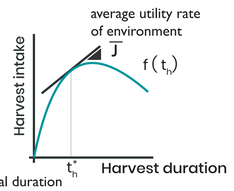
1 . Introduction and Theory

When you're picking apples in an orchard,

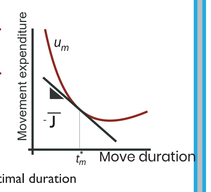
- How long should you spend at one tree?
- How fast should you move to the next tree?

Marginal Value Theorem and extension :

"The predator should leave a patch it is presently in when the marginal capture rate in the patch drops to the average capture rate for the habitat."
— Charnov (1976)



Movement vigor between patches is optimal when the magnitude rate of movement expenditure equals the average capture (utility) rate of the environment.—Yoon et al (2018)

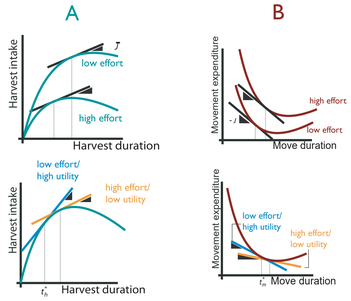


GOAL: To validate the use of **Marginal Value Theorem** to predict foraging decisions made in human arm reaching.

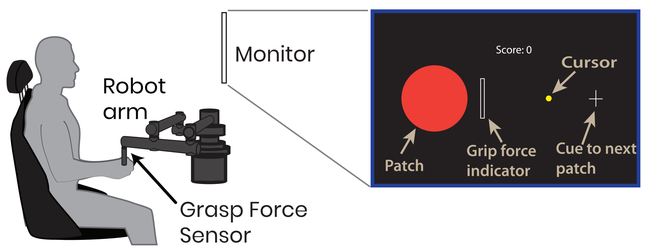
HYPOTHESES:

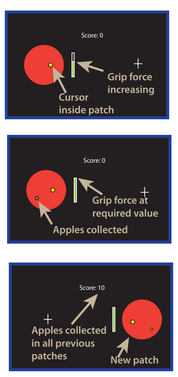
H1. With an increase in harvest effort (movement effort) within an environment, harvest duration increased (movement vigor decreases)

H2. After a history of high effort, harvest duration increases (movement vigor decreases) for equivalent effor requirements.

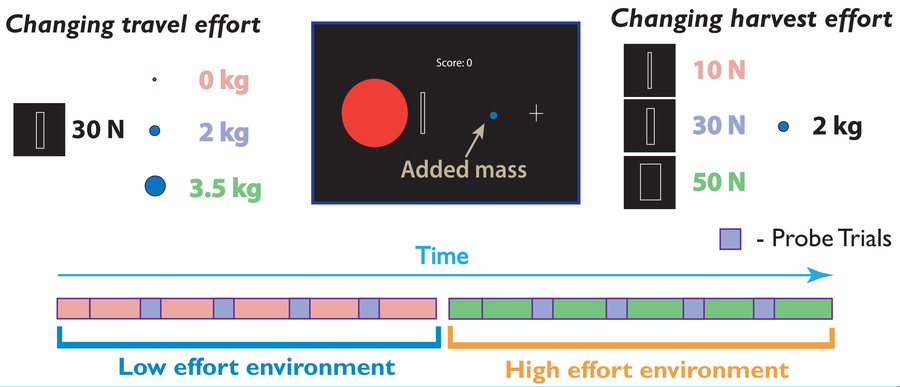


2. A foraging protocol for arm reaches





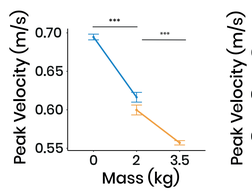
- Subjects (n=12) were recruited to perform the the experiment with changing travel effort.
- 9 of those subjects were asked to return to participate in the experiment with changing harvest effort.
- Subjects received 1¢ in monetary bonus for every ten apples collected.

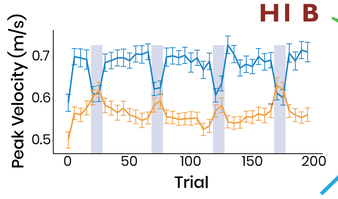


3. Movement vigor is modulated by changing travel effort

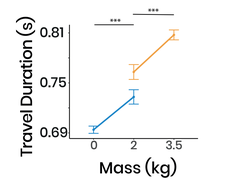
Peak velocity (PV) decreased significantly ($p<0.001$) with increase in added mass within and across environments.

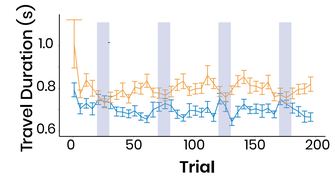
H1 B ✓



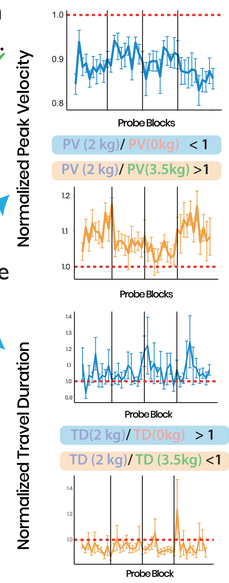


PV and TD in probe normalized to average of non-probe trials in block.

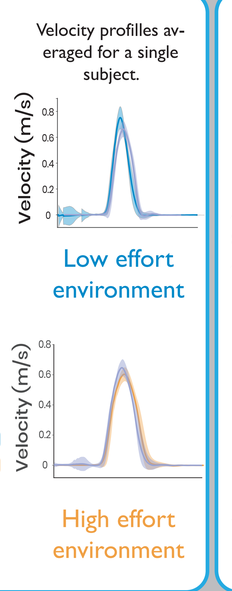




Travel Duration (TD) increased significantly ($p<0.001$) with added mass within and across environments.



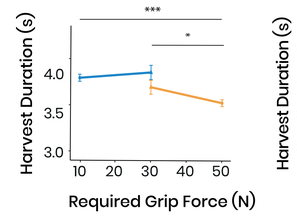
Velocity profilles averaged for a single subject.

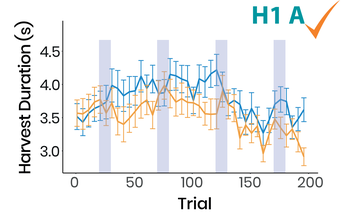


4. Time in patch is affected by changing harvest effort

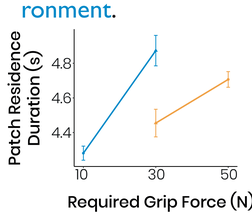
Harvest Duration (HD) decreased for increase in harvest effort within the high effort environment ($p< 0.05$) as well as between environments

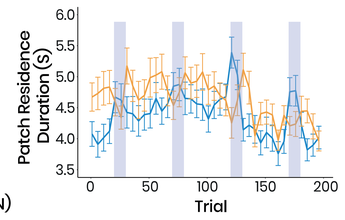
H1 A ✓

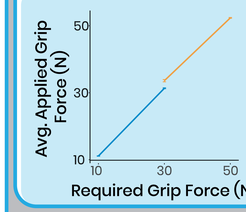




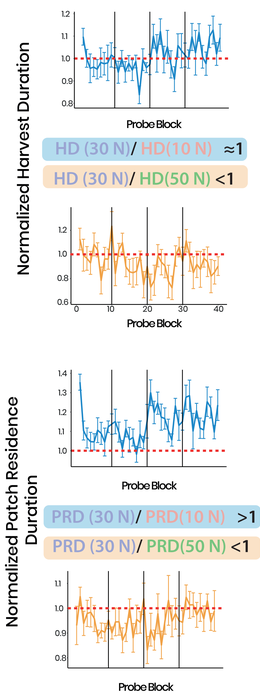
Total patch residence duration (PRD) increased in high effort environment as compared to the low effort environment.





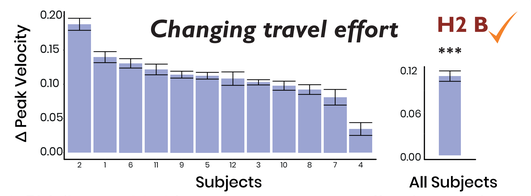


Grip force applied on average by subjects was in adherance with required force levels.

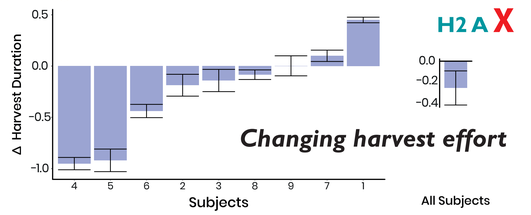


HD and PRD in probe normalized to average of non-probe trials in block.

5. Probe within environments



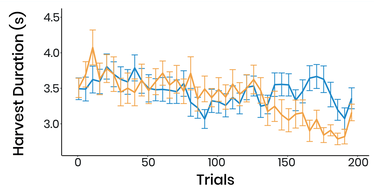
Δ PV (Low - High) is positive across all subjects ($p< 0.001$); vigor *significantly decreases* for probe trials in the high effort environment.



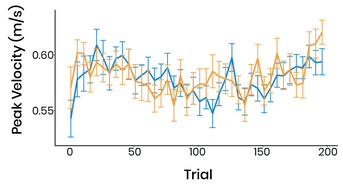
Δ HD(High - Low) is negative; harvest duration *does not increase* for probe trials in high effort environment.

6. No crossover effects observed

Increased travel effort in environment didn't lead to increased harvest duration.



Increased harvest effort in environment did not lead to reduced movement vigor.



7. Conclusions

1. Movement vigor is modulated by change in travel effort within an environment, in accordance with MVT. H1 B ✓

2. Harvest duration increased with increase in harvest effort across environments and within the high effort environment, in accordance with MVT. H1 A ✓

3. Changing travel effort led to decreased movement vigor in probe blocks belonging to high effort environment when compared to the low effort environment. H2 B ✓

References

1. Charnov, E. L. (1976) in Theoretical Population Biology, 9,129-136.
2. Yoon, T., et al (2018) in Proceedings of the National Academy of Sciences, 115(44), E20476-E104

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