

Individual Experience Alone Can Generate Lasting Division of Labor in Ants

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Motivation & Goal

- M: “Individual experience has been suggested to influence workers ... but its potential impact on the organization of insect societies has yet to be demonstrated” (Ravary, et al, 2007)
- G: “Here we will show that, all else being equal, ant workers engage in distinct functions in accordance with their previous experience” (Ravary, et al, 2007)

Summary

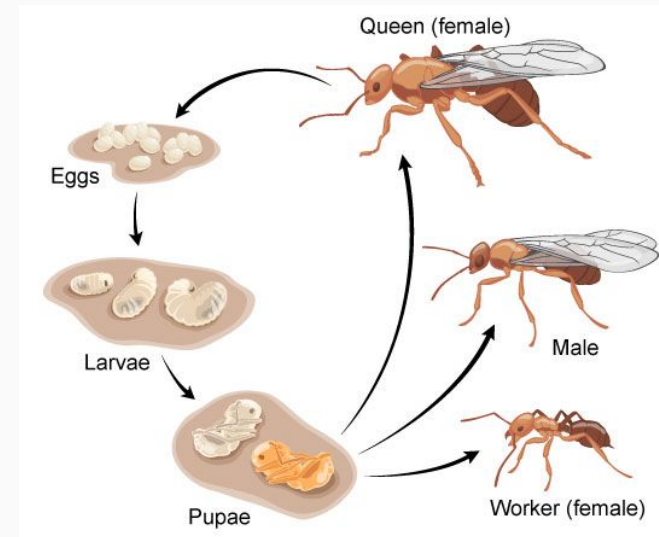
- We train ants based on foraging experience
- Some will be trained as successful, others unsuccessful
- Will this experience impact what job the individual will prefer permanently?
- We will test how this experience affects their behavior and create differences between the two populations

The Ant

- *Cerapachys biroi*
- Phasic reproduction - New generation of workers occur synchronously every 34 days
- Thelytoky Parthenogenesis - Form of asexual reproduction - full/half clones
- Same cohort = Same age, size, shape & development conditions
- Homogeneity helps for control
- Birth>Foraging>Statory(Pupating & Laying)>Foraging

Maturation - Day 0 to 34

- Day 0 - beginning
 - 80 pupae, 25 workers (To help pupae)
- Day - 3 Labeled
 - 80 moved to new nest and labeled, 15 larvae (Nesting behavior), older discarded
- Day ~34 - Introduce 10 older forger (recruiters)



Training Period - Day 35 to 50

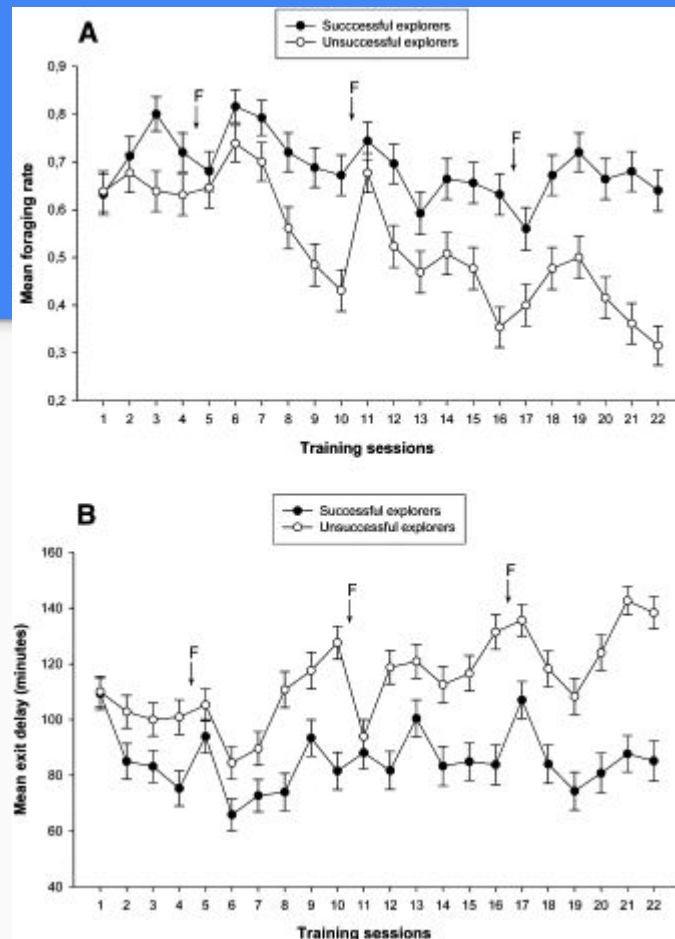
- Nest has a single controlled exit
- Two cup for training, one with prey, one empty
- Some prey in foraging area to start the behavior
- Older forager go out, see food, recruit younger worker
- Young outgoing workers assigned a cup. “Successful” or “Unsuccessful”. (Can’t actually retrieve prey)
- Older worker (sees that younger worker disappeared) recruits more
- After 3 hours, the nest closed. Everyone is brought into nest through a trapdoor
- 2 sessions per day. Min 2 hr interval.
- Fed through trap door every 3 days. (No training the day after)
- Discard older workers

Testing Period/Long Term Effects - Day 68 to 84

- After statary
- The now pupae and newly laid eggs discarded, replaced with 15 larvae
- Open nest, never closed again
- 40 scanning observations & classify behavior, min 1 hr between
- Observed five behaviors
 - Exploration
 - Brood care
 - Immobility (away from brood, in brood vicinity, upon brood)

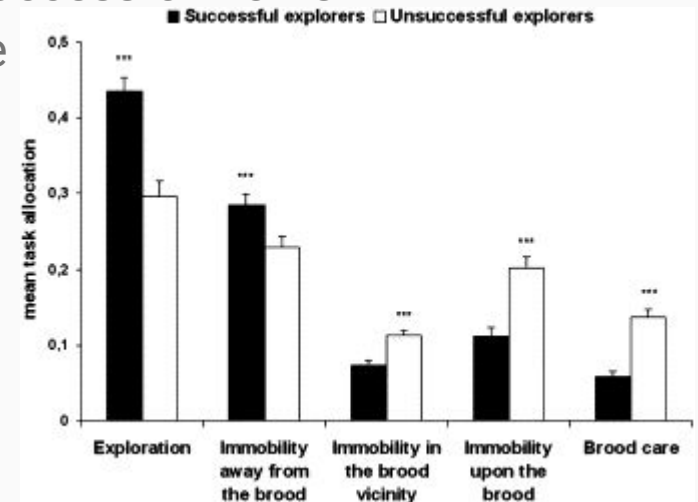
Result - training

- Train naive workers - ½ success ½ fail
- Mean foraging rate and mean exit delay
- Clear divergence between the two groups very quickly (seven sessions)
- After food, foraging rates increase and delay decreases
- Food increase homogeneity



Results - testing/long term

- 5 behaviors correlated to successful and unsuccessful worker
- Successful worker were more likely to explore
- Unsuccessful worker were more likely to nest



(Ravary, et al, 2007)

Conclusion

- “Here we have shown that individual experience also can affect the dynamics of task specialization by shaping ants’ behavior, probably through a lasting modification of their internal response thresholds” (Ravary, et al, 2007)

Strength 1

- Using the properties of the ant to control and structure the experiment
 - Phasic reproduction
 - Guarantees that all ants are the same age and develop identically due to rigid & synchronous 34 day cycle
 - Parthenogenesis
 - Reduces genetic diversity between nestmates
 - This reduction suppresses (as much as possible) differences in behavior due to genetics

Strength 2

- Use of additional ants to create desired behaviors without polluting the test population
 - Behaviors to create division of labor (foraging and nesting) needed catalyst to be trained in a repeatable manner
 - Using older worker to recruit and start foraging behavior
 - Using younger larvae to give children to brood and nest
 - Keeps the test population the same age
 - Avoids using artificial methods (Forceps. See Weakness 1)

Strength 3

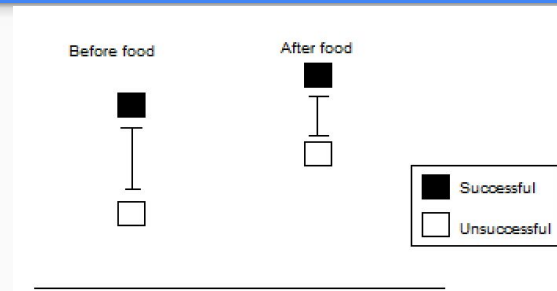
- When divergence in training happened quicker than expected, the authors speak about proximity to brood modifying task allocation.
 - This is okay despite being unexpected because this is still part of a natural experience that can contribute to division of labor in ants
 - They were able to conjecture a reason for this divergence
 - Their results in testing support that this may be the case
 - Provides another factor to test in further research

Weakness 1

- Placing ants using forceps into the training containers/back into nest
 - Reduce ants motivation to forage
 - Imagine an alien picking you up, giving half pop. food and the other none. Want to go outside still?
 - This reduction potentially shifts behavior towards nesting and less foraging
 - Potentially eliminate low population behaviors - reduce diversity of behaviors and change results
 - Use a bridge or one way doors to enter container. *

Weakness 2

- Directly feeding the ants contributes to homogeneity
 - After feeding both populations become similar
 - More motivation to forage and decrease exit delay
 - They confirm
 - Providing food is equivalent to being successful
 - Un-trains unsuccessful individuals slightly
 - Successful vs unsuccessful is now successful vs mostly unsuccessful
 - This change in composition (while potentially small due to retraining) can potentially skew results
 - Allow ants to return prey (With limit) *



Weakness 3

- Training sessions 11 and 13 had reduced significant differences between populations for unknown reasons
 - These sessions don't have an adequate explanation
 - Not great since the experimental goal is to show the impact of experience when "all else being equal"
 - Potential unknown contributing factor or inadequate measures

Extension 1

- How do the the extreme cases of experience (all successful or unsuccessful) impact division of labor and how does the state of an individual counteract this? If it does.
 - A robust system should survive. Experience is not the sole contributing factor. But do they adapt to late.
 - This is related since we are looking at the extreme cases of experience.
 - This can isolate other factors that contribute to division of labor
 - Internal state
 - Social interaction

Extension 2

- Does division of labor imply each ant is tasked with what they are best at?
 - Original experiment indicates that experience is important to task allotment
 - Wouldn't the most efficient and robust system involve individuals doing what they are most experience with?
 - Shows that the micro level might be very different from the macro level

Extension 3

- How does population size affects the division of labor?
 - As need increases do colonies scale to fulfil needs?
 - Related because this explores another contributing factor to the division of labor
 - Smaller populations rely on multi-skilled individuals
 - As population goes up, humans specialize but also create new specialties (potentially more efficient)
 - Do new divisions emerge? More immobile ants? Behaviors stay the same but population of behaviors increase?

Bibliography

Ravary, Fabien, et al. "Individual experience alone can generate lasting division of labor in ants." *Current Biology* 17.15 (2007): 1308-1312.

"School of Life Sciences | Ask A Biologist." *Individual Life Cycle of Ants | ASU - Ask A Biologist*, 9 May 2010, askabiologist.asu.edu/individual-life-cycle.