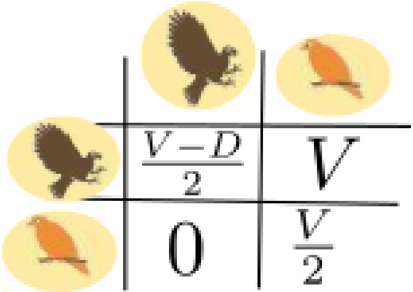
The evolution of badges of status with learners

Andrés Quiñones

The Hawk-Dove game

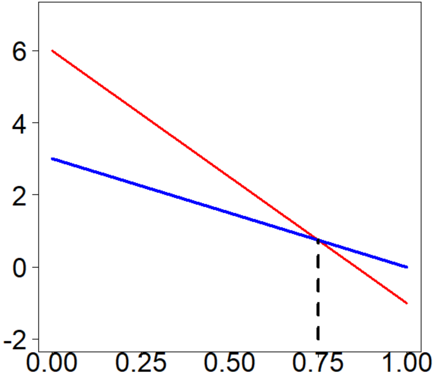
Individuals have one of two genetically determined phenotypic strategies. *Hawks* are willing to start a conflict over resources, while *doves* prefer to stand down in the hope to share the resource without an aggressive contest.



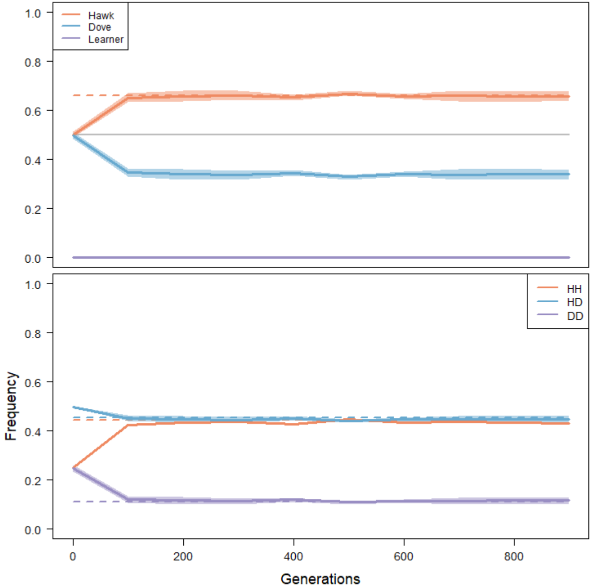
The hawk-dove game

$$w_H = p_H \frac{V - C}{2} + (1 - p_h) V$$

$$w_D = p_H 0 + (1 - p_H) \frac{V}{2}$$



The hawk-dove game



What about signals?

What about signals?

When are signals honest?

- Impossible to fake
- Individuals have common interests
- Handicap principle (signal´s cost is proportional to quality)
  - Social costs?

Social costs are an underappreciated force for honest signalling in animal aggregations

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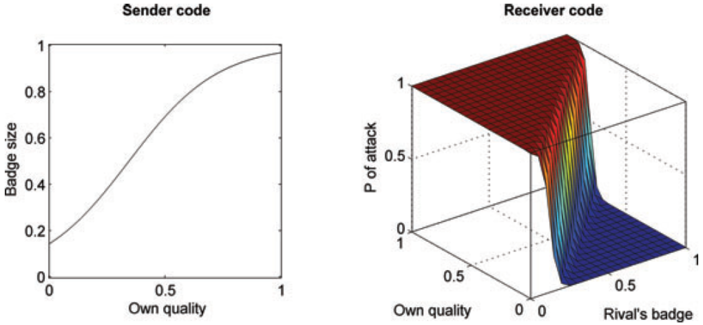

What about learning?

Associative learning

Reinforcement learning theory

$$\Delta V_{t(s)} = \alpha \underbrace{(R_t - V_t)}_{\text{prediction error}}$$

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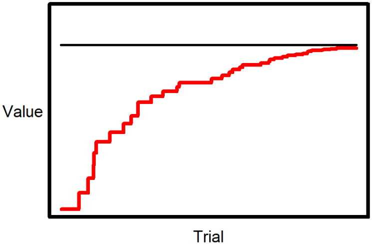
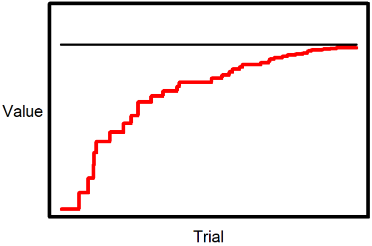
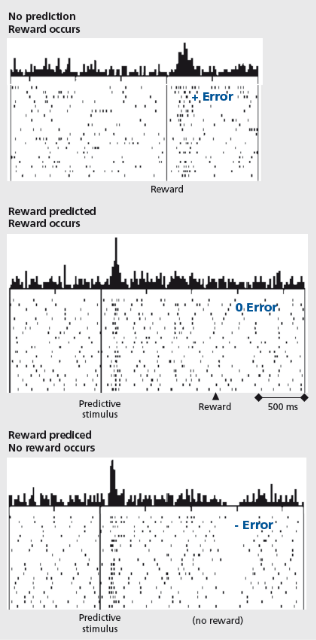


Reinforcement learning theory

$$\Delta V_{t(s)} = \alpha \underbrace{(R_t - V_t)}_{\text{prediction error}}$$





Reinforcement learning theory

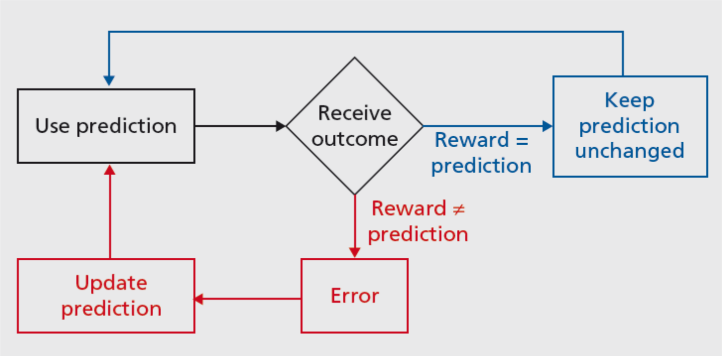
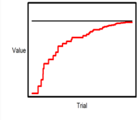
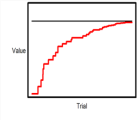


Figure 1. Scheme of learning by prediction error. Red: a prediction error exists when the reward differs from its prediction. Blue: no error exists when the outcome matches the prediction, and the behavior remains unchanged.

Environmental states

Discrete states





Environmental states

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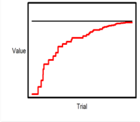
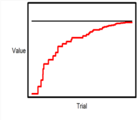
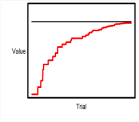


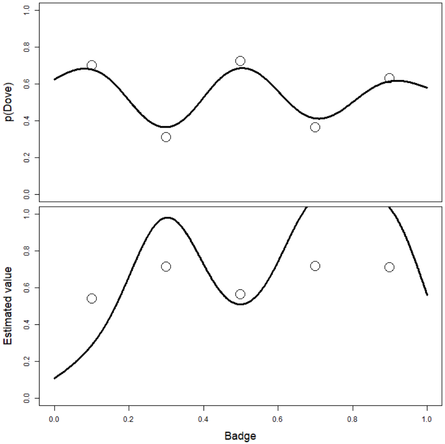


Continuos states



Continuos environmental states

$$\Delta V_{t(s)} = \alpha \underbrace{(R_t - V_t)}_{\text{prediction error}}$$

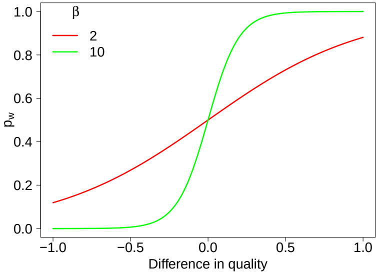


Our model

The hawk-dove game 2.0

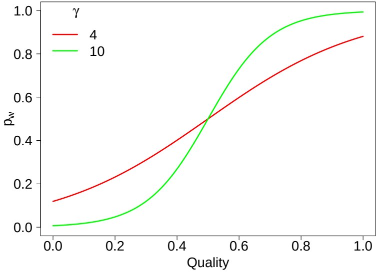
	H	D
H	$p_w V \frac{-C}{2} + (1 - p_w)\frac{-C}{2}$	V
V	0	$\frac{V}{2}$

$$p_w = \frac{1}{1 + e^{-\beta(Q_i - Q_j)}}$$



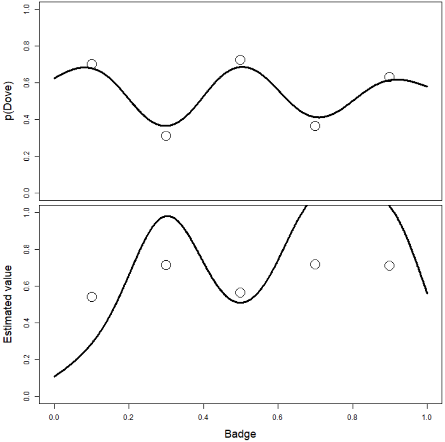
Sender Code

$$s_i = \frac{1}{1 + e^{-(\epsilon_i + \gamma_i Q_i)}}$$



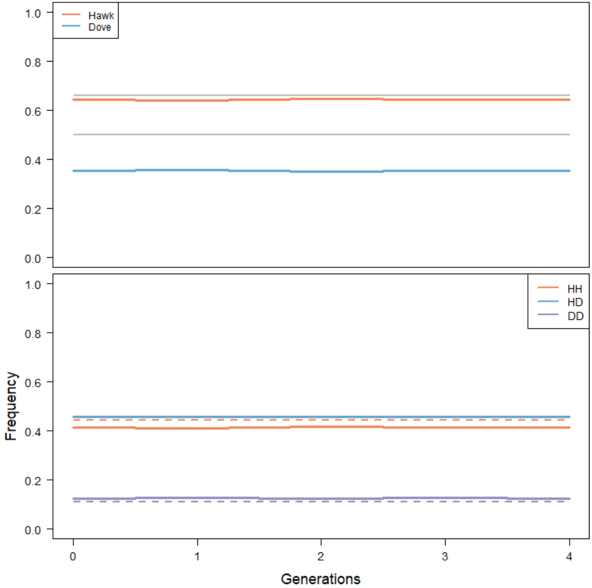
Receiver code

$$\Delta V_{t(s)} = \alpha(R_t - V_t)$$

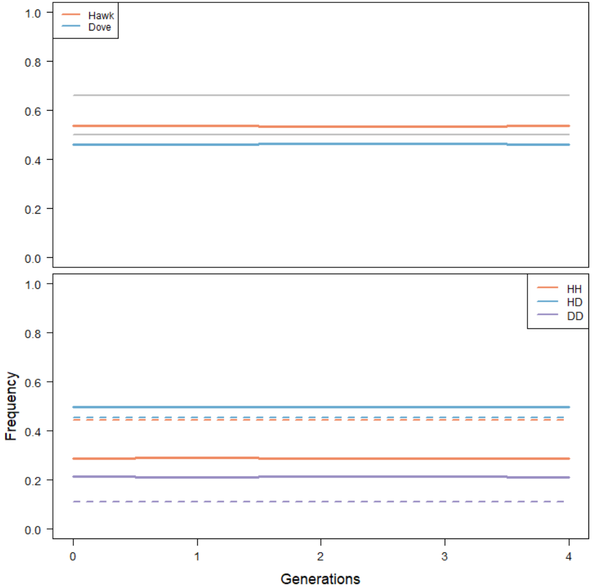


Results

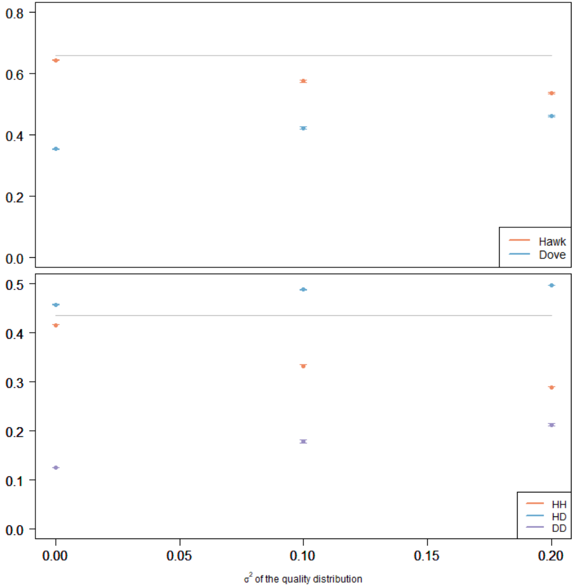
When individuals do *NOT* vary in quality



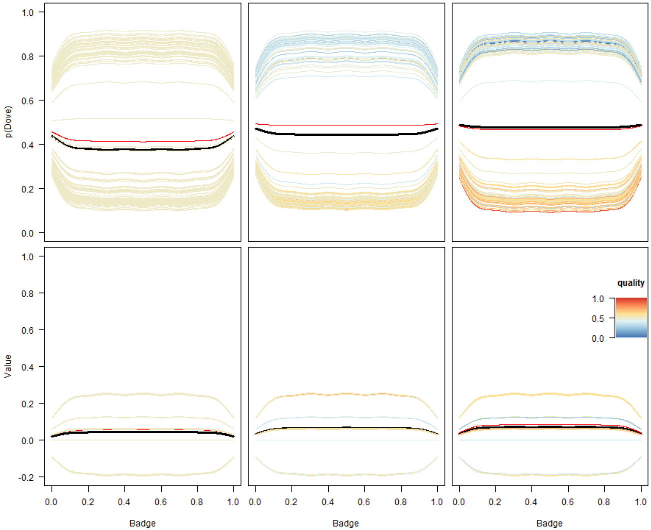
When individuals *DO* vary in quality



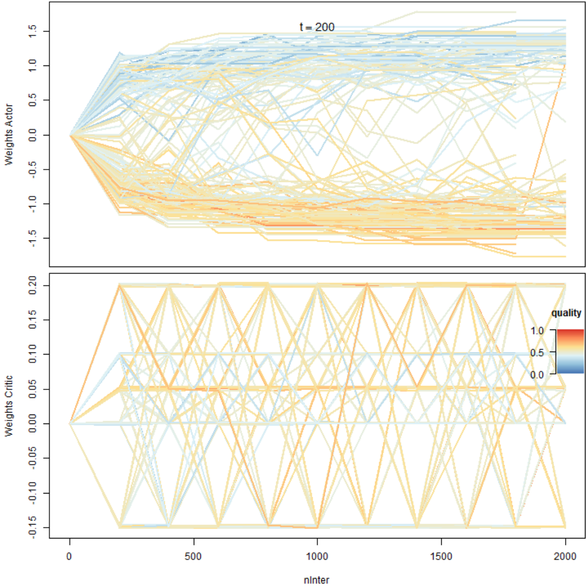
Overal effect of quality variation



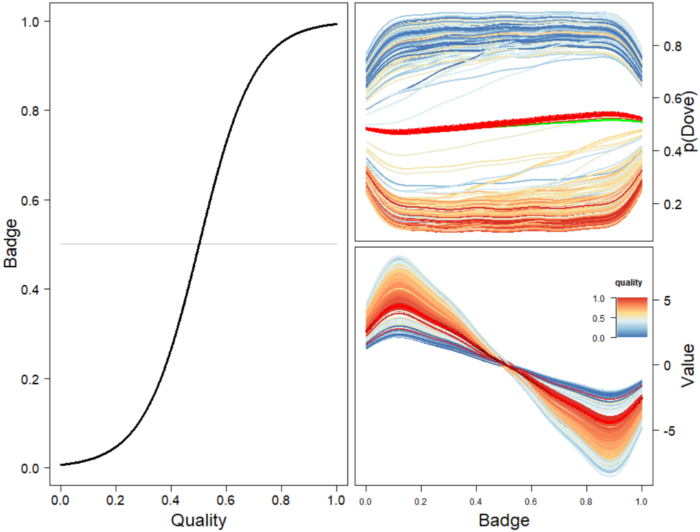
How does variation among *learners* look like?



How do the learning dynamics look like?

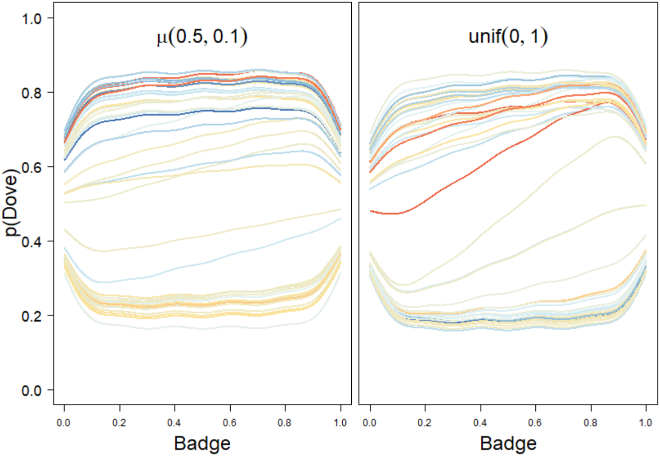


How do learners behave when signals are honest?



What parameters influence responsiveness?

Distribution of quality



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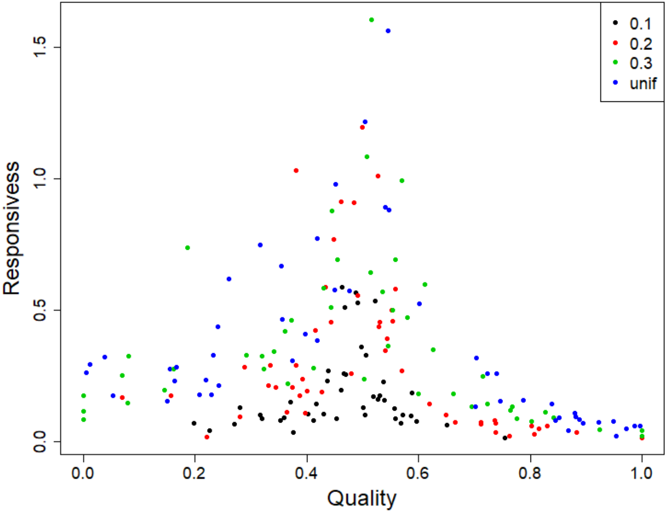
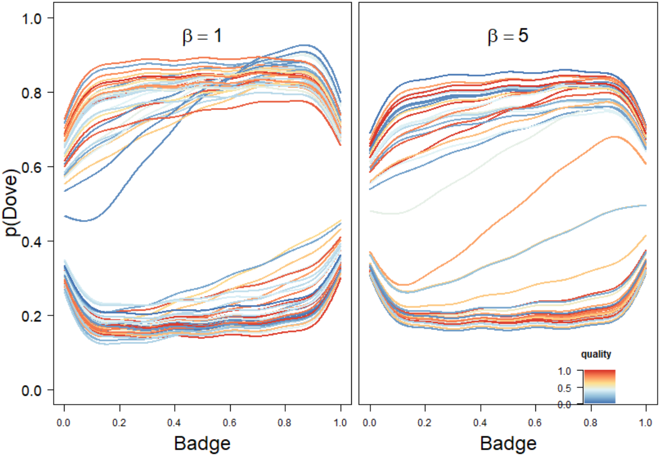


What parameters influence responsiveness?

Strength of quality influence on competition outcome



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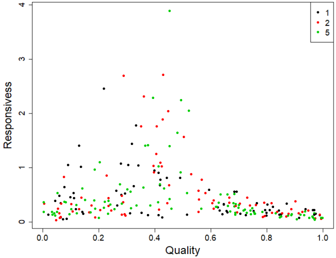
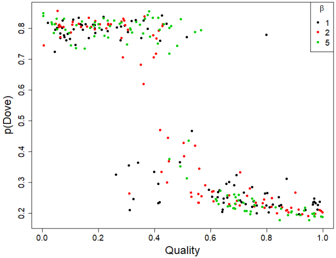
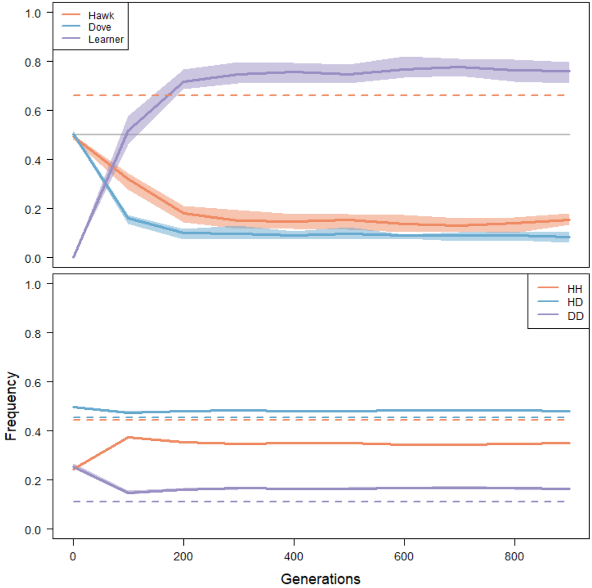




Why the hell is responsiveness so low?

How do learners fare against pure strategies?



Concluding

- Learning is good, even if you do not learn about your opponent. You still learn about you
- Learning reduces aggressive interactions
- Learning splits up individuals into *types*

What's next?

- Let reaction norm evolve, under different initial conditions.
- Let learning parmeters evolve
- Let the communication system co-evolve