

Competition in *A. leptorhynchus*

-

How and why ?

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RESEARCH ARTICLE

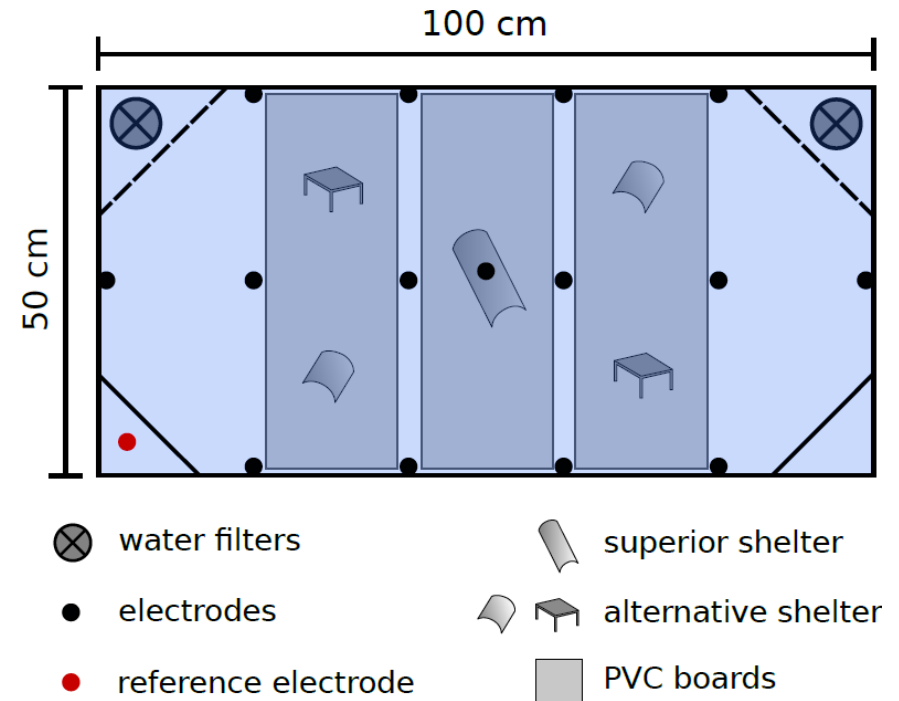
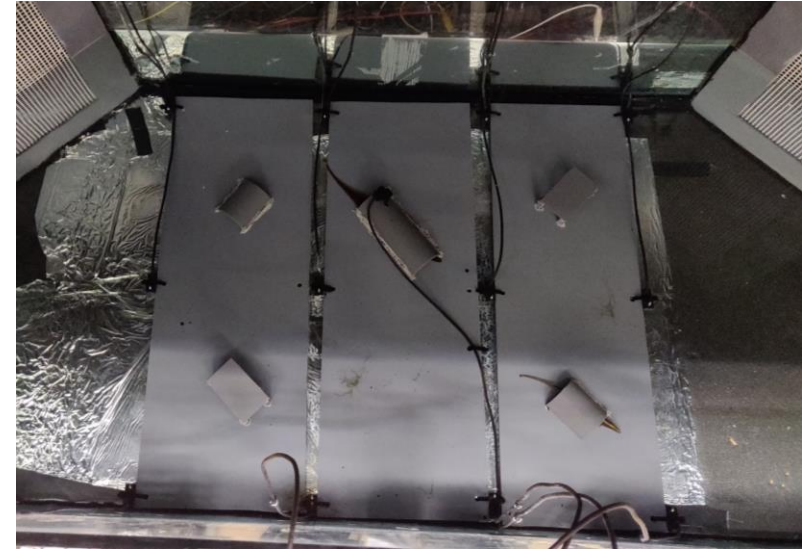
Electrocommunication signals indicate motivation to compete during dyadic interactions of an electric fish

Till Raab^{1,2,*}, Sercan Bayezit¹, Saskia Erdle¹ and Jan Benda^{1,2,3}

Staged competitions

Experimental condition:

- pairs of fish
- competition for a superior shelter
- 6h trials
 - 3h/3h dark/light



Staged competitions

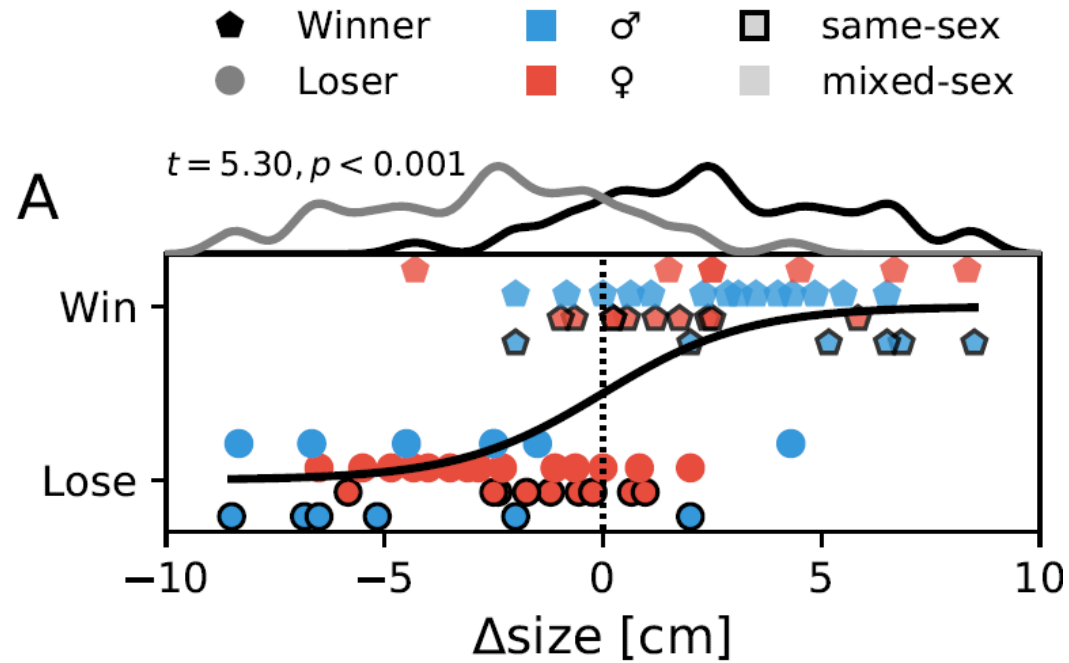
Dark



Light



Winners are determined by a larger body-size



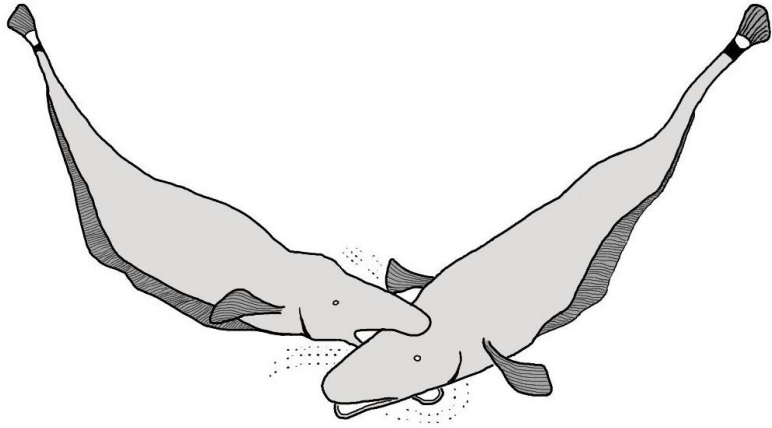
... body-size

... EOD frequency

... sex

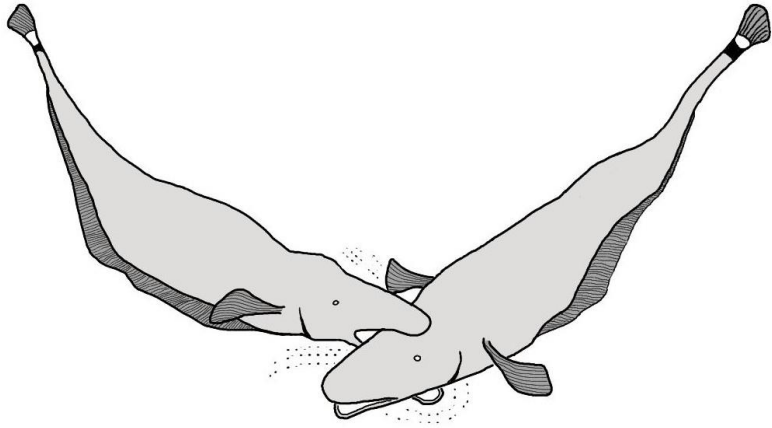
Interactions during dyad competitions

Agonistic interactions



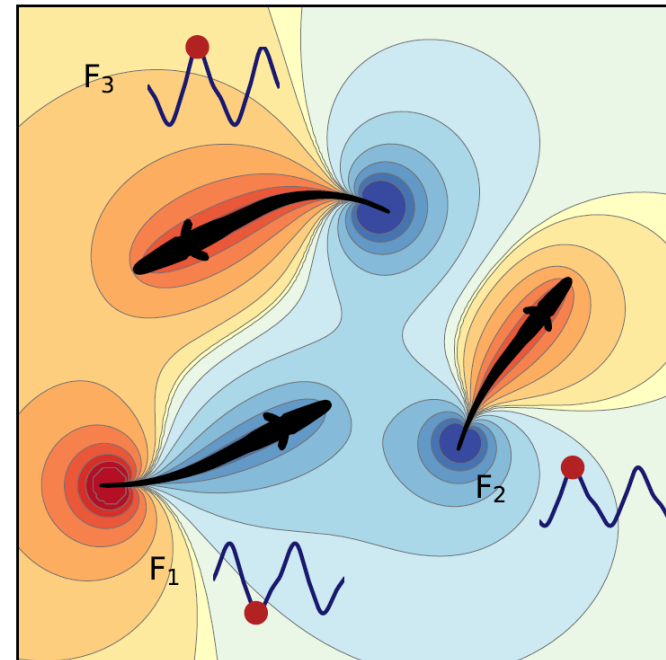
Interactions during dyad competitions

Agonistic interactions



Electrocommunication

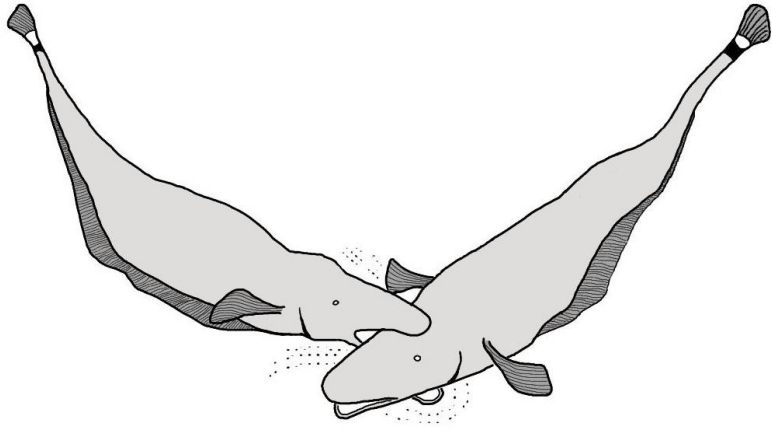
A



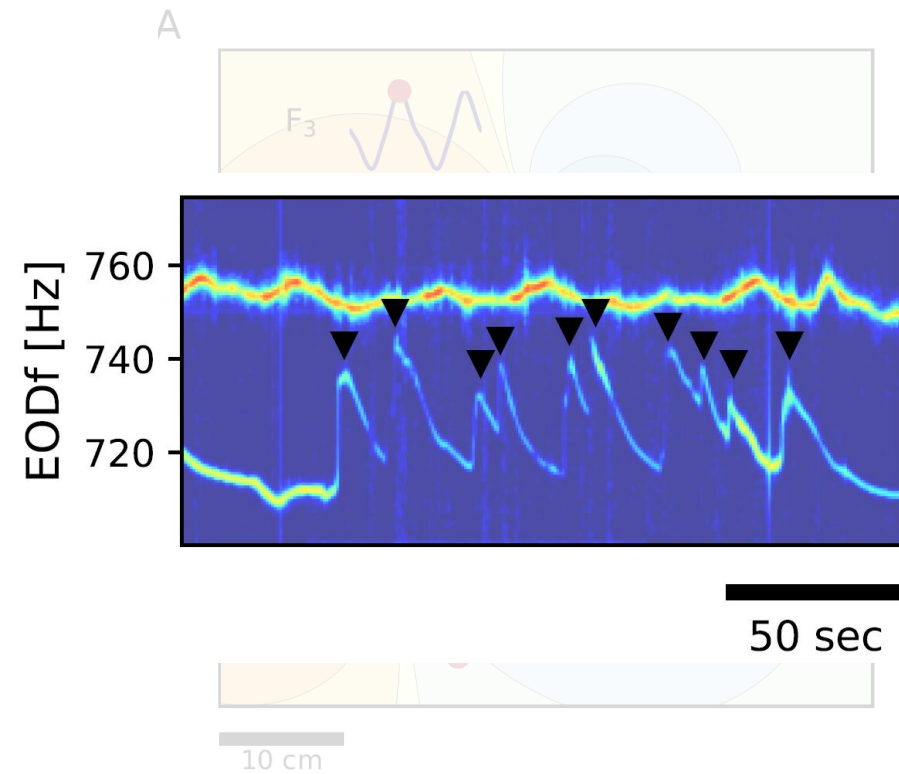
10 cm

Interactions during dyad competitions

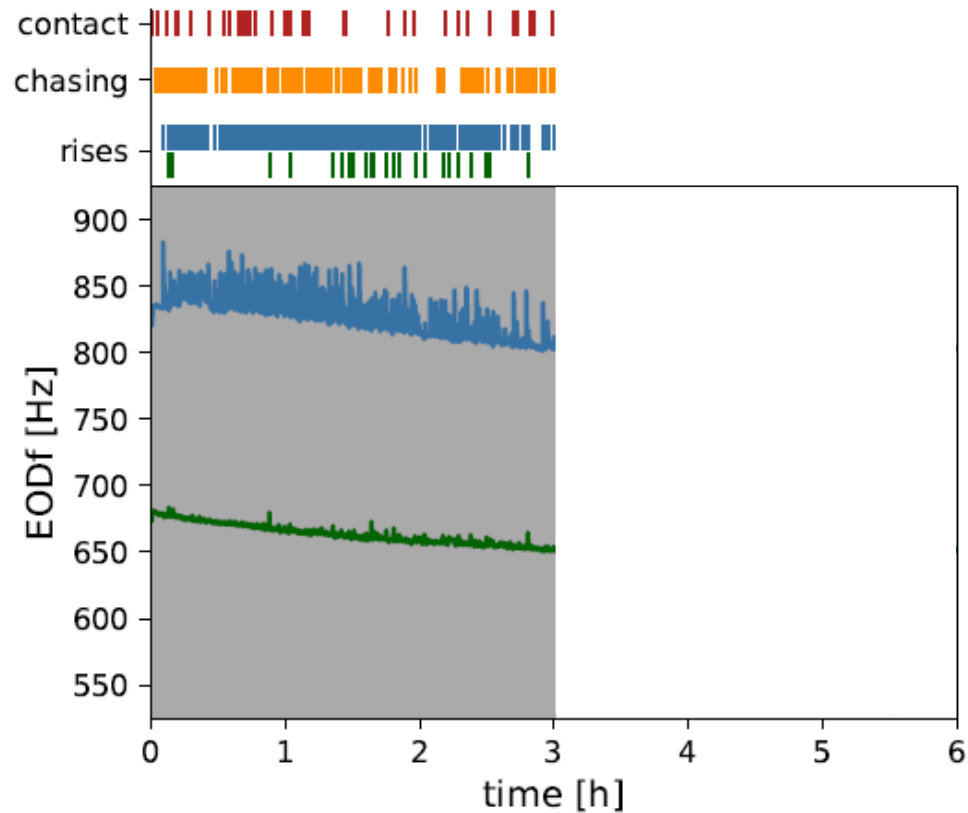
Agonistic interactions



Electrocommunication with rises



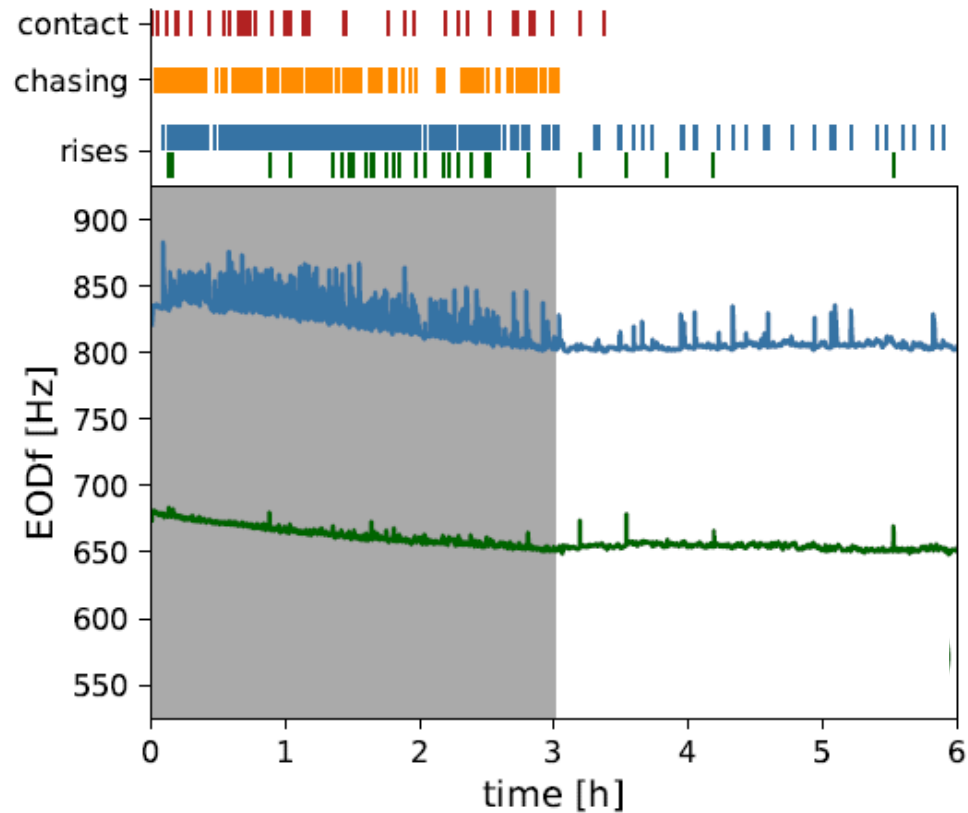
Interactions during dyad competitions



Dark phase (active):

- agonistic encounters
- many rises

Interactions during dyad competitions



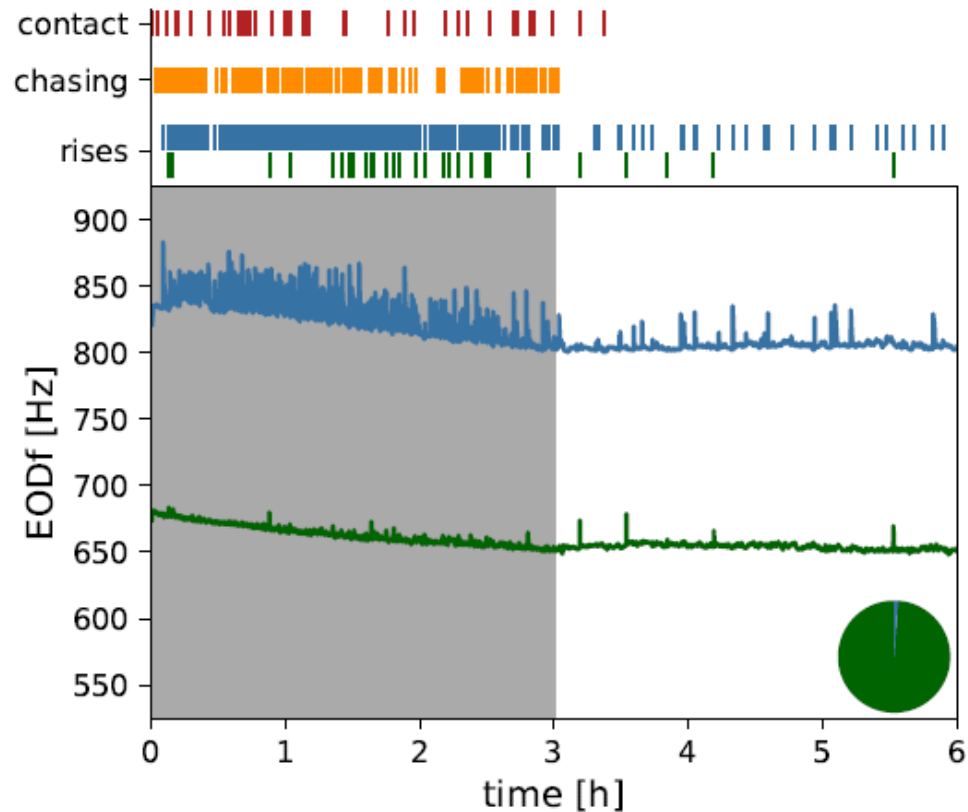
Dark phase (active):

- agonistic encounters
- many rises

Light phase (inactive):

- less interactions

Interactions during dyad competitions



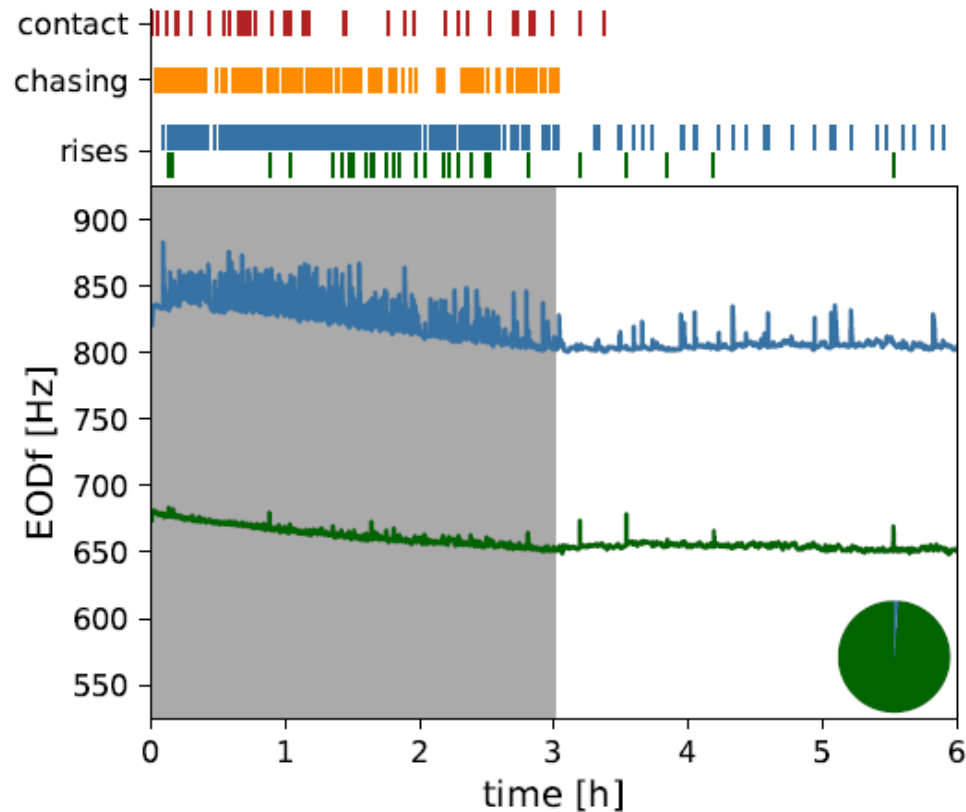
Dark phase (active):

- agonistic encounters
- many rises

Light phase (inactive):

- less interactions
- winners occupy shelter

Interactions during dyad competitions



Dark phase (active):

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- many rises

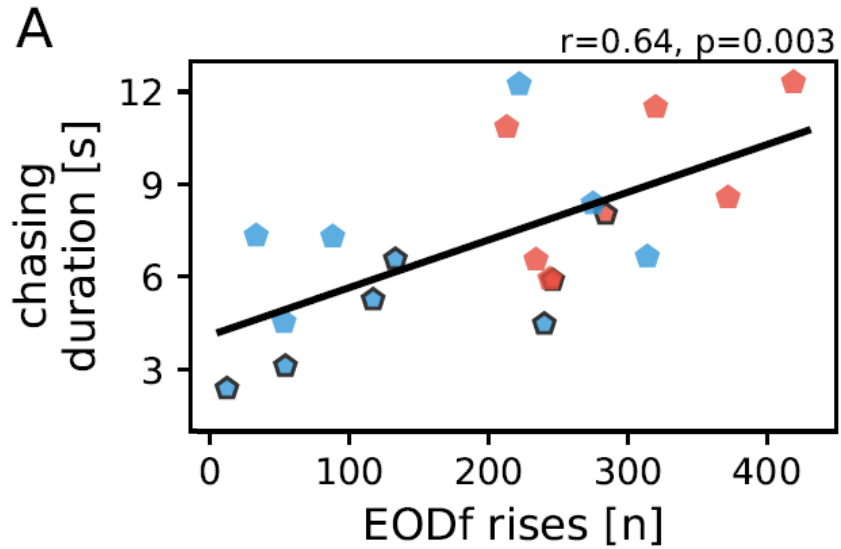
Light phase (inactive):

- less interactions
- winners occupy shelter

→ Losers emit Rises

→ Winners initiate attacks

Rises affect agonistic events

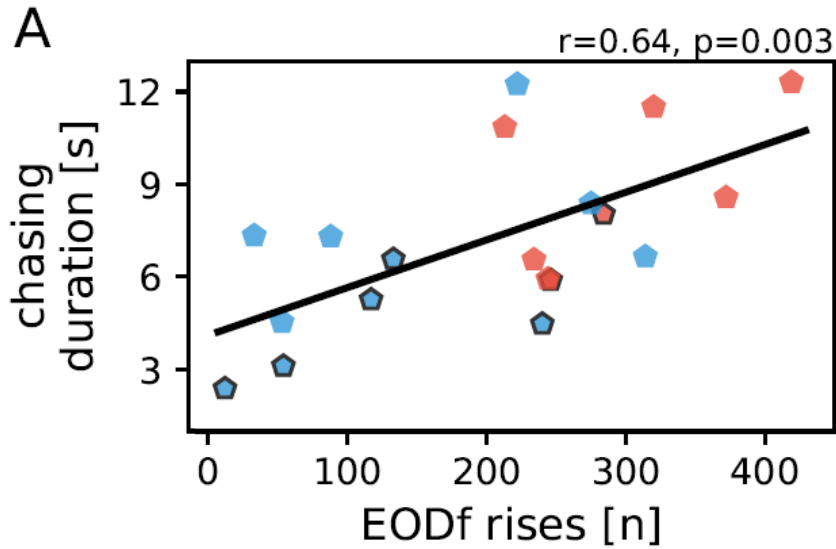


more rises



longer chasing events

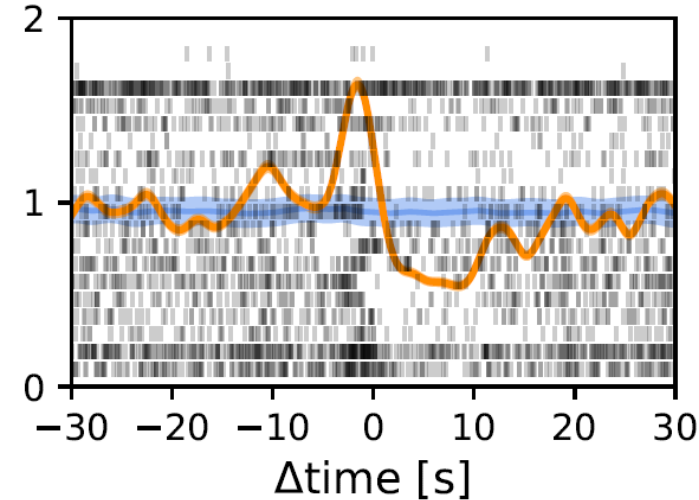
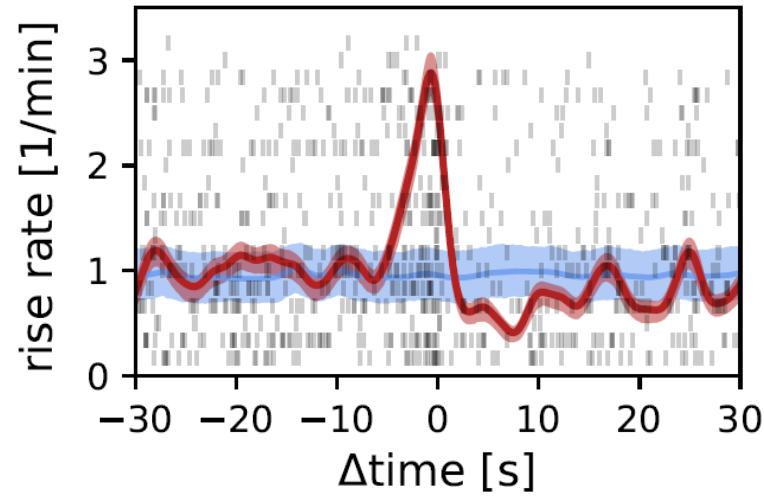
Rises affect agonistic events



more rises



longer chasing events



Rises trigger...



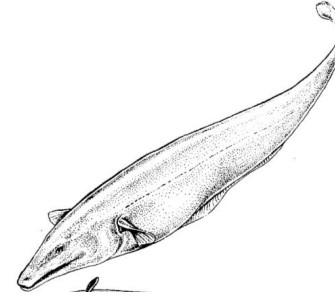
physical attacks



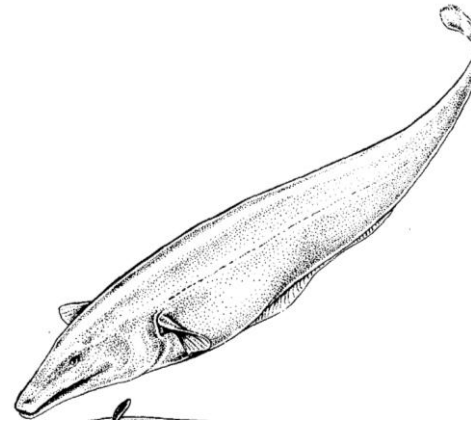
chasing events

A. leptorhynchus assess their opponents

Resource Holding Potential (RHP) ~ body-size



RHP (fish 1)



RHP (fish 2)

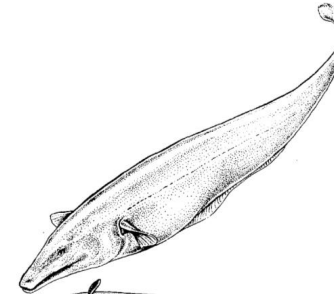
A. leptorhynchus assess their opponents

Resource Holding Potential (RHP) ~ body-size

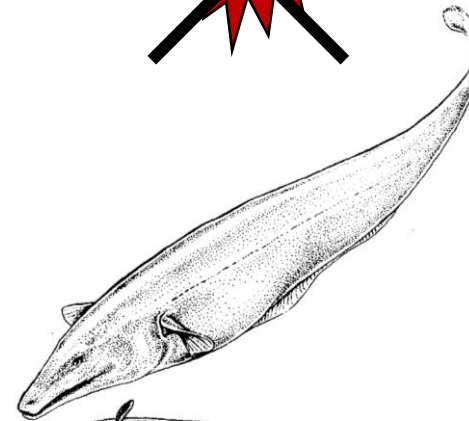
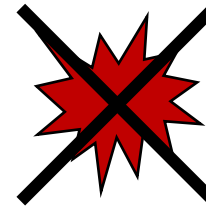
Self assessment

Accumulate competition costs:

- from own actions



RHP (fish 1)



RHP (fish 2)

A. leptorhynchus assess their opponents

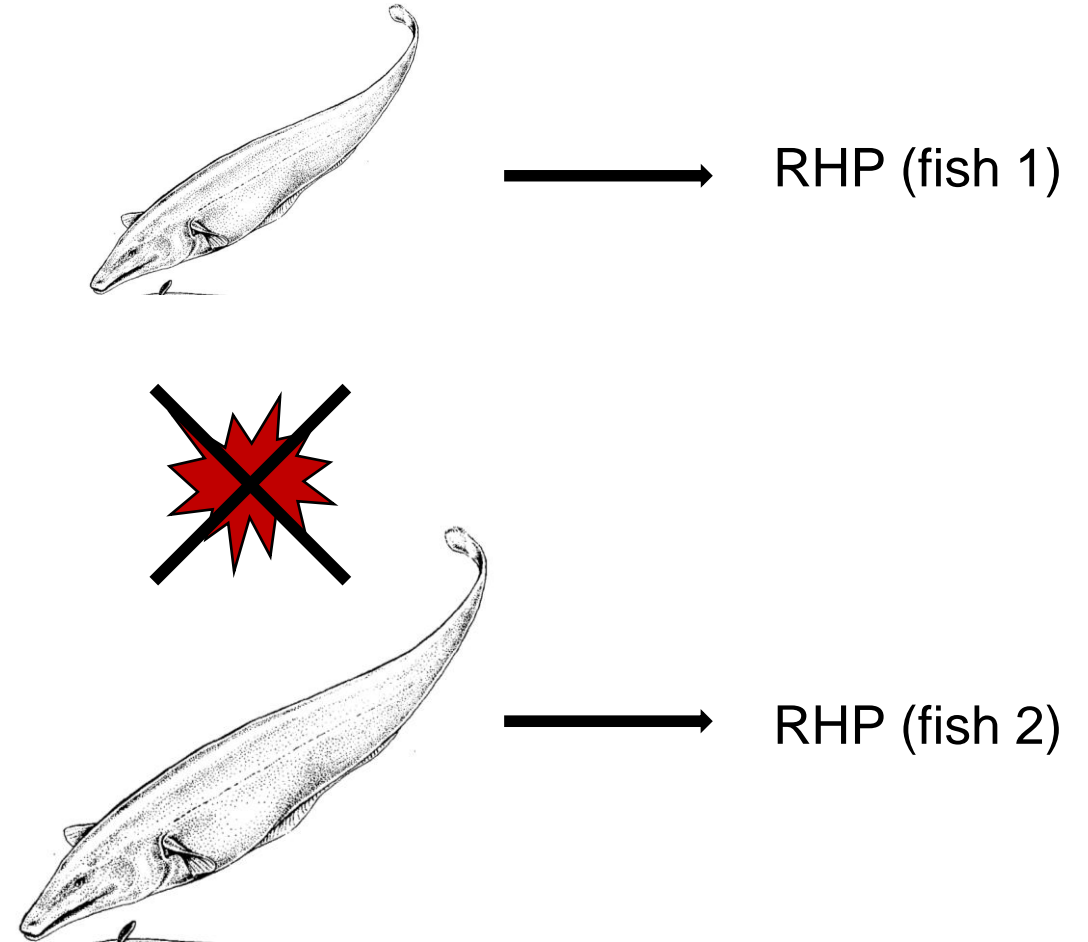
Resource Holding Potential (RHP) ~ body-size

Self assessment

Accumulate competition costs:

- from own actions

➤ Retreat when RHP threshold is reached



A. leptorhynchus assess their opponents

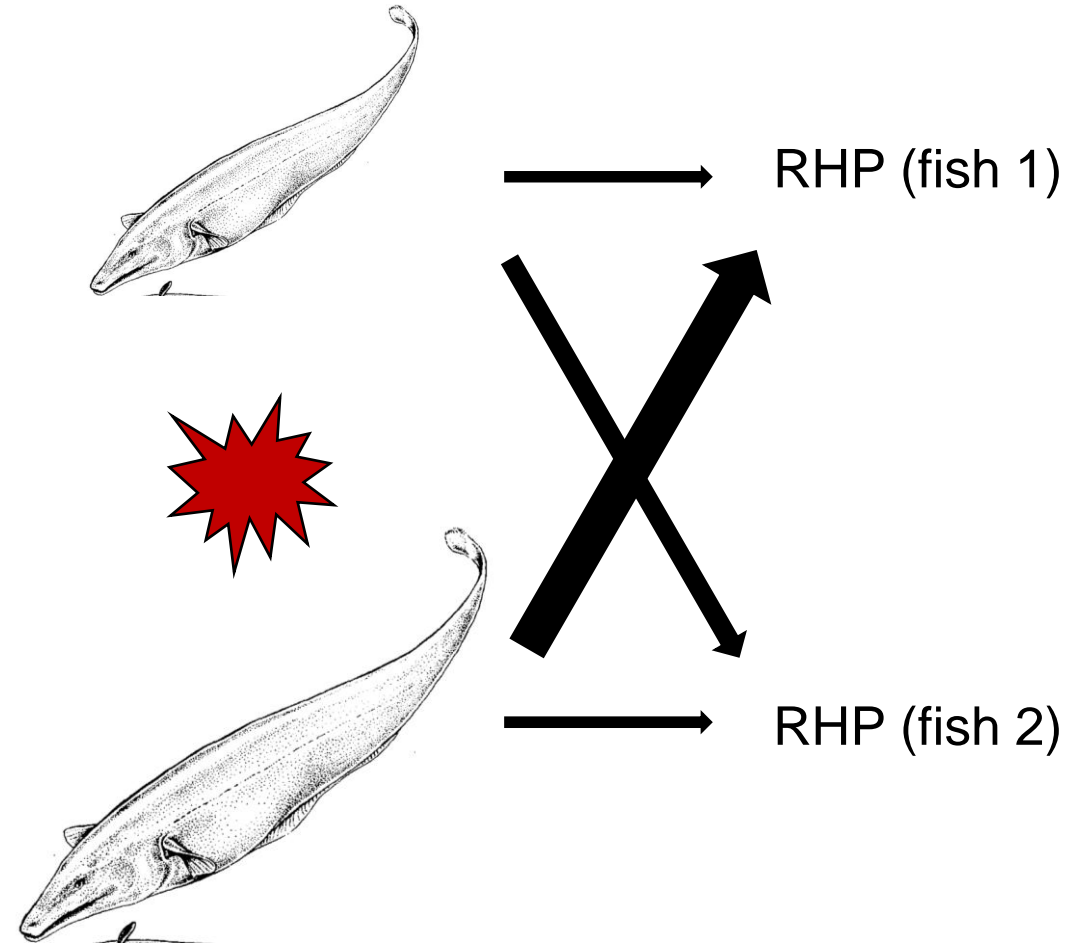
Resource Holding Potential (RHP) ~ body-size

Cumulative assessment

Accumulate competition costs:

- from own actions
- Inflicted by opponent

➤ Retreat when RHP threshold is reached



A. leptorhynchus assess their opponents

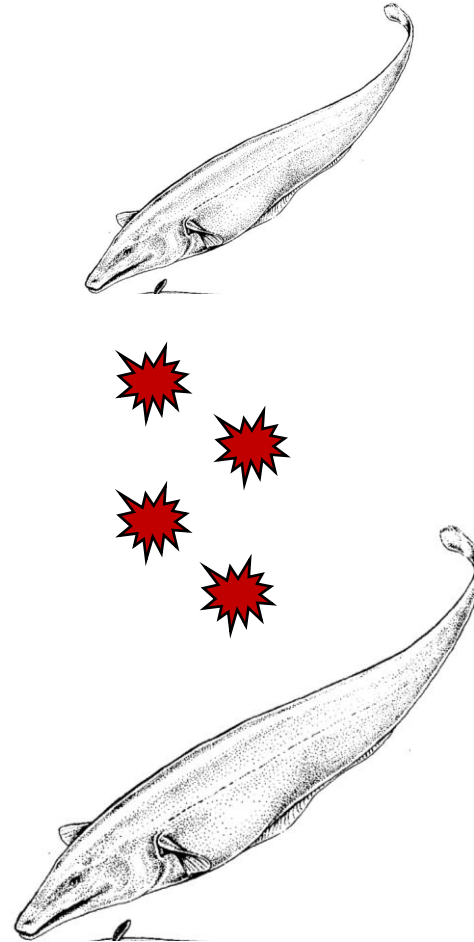
Resource Holding Potential (RHP) ~ body-size

Mutual assessment

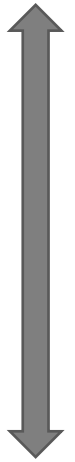
Estimate Δ RHP:

- Repetitive RHP probing
- Ritualized non-severe fighting

➤ Adjust behavior according to Δ RHP



RHP (fish 1)



RHP (fish 2)

How to distinguish assessment models

How to distinguish assessment models

Simulations

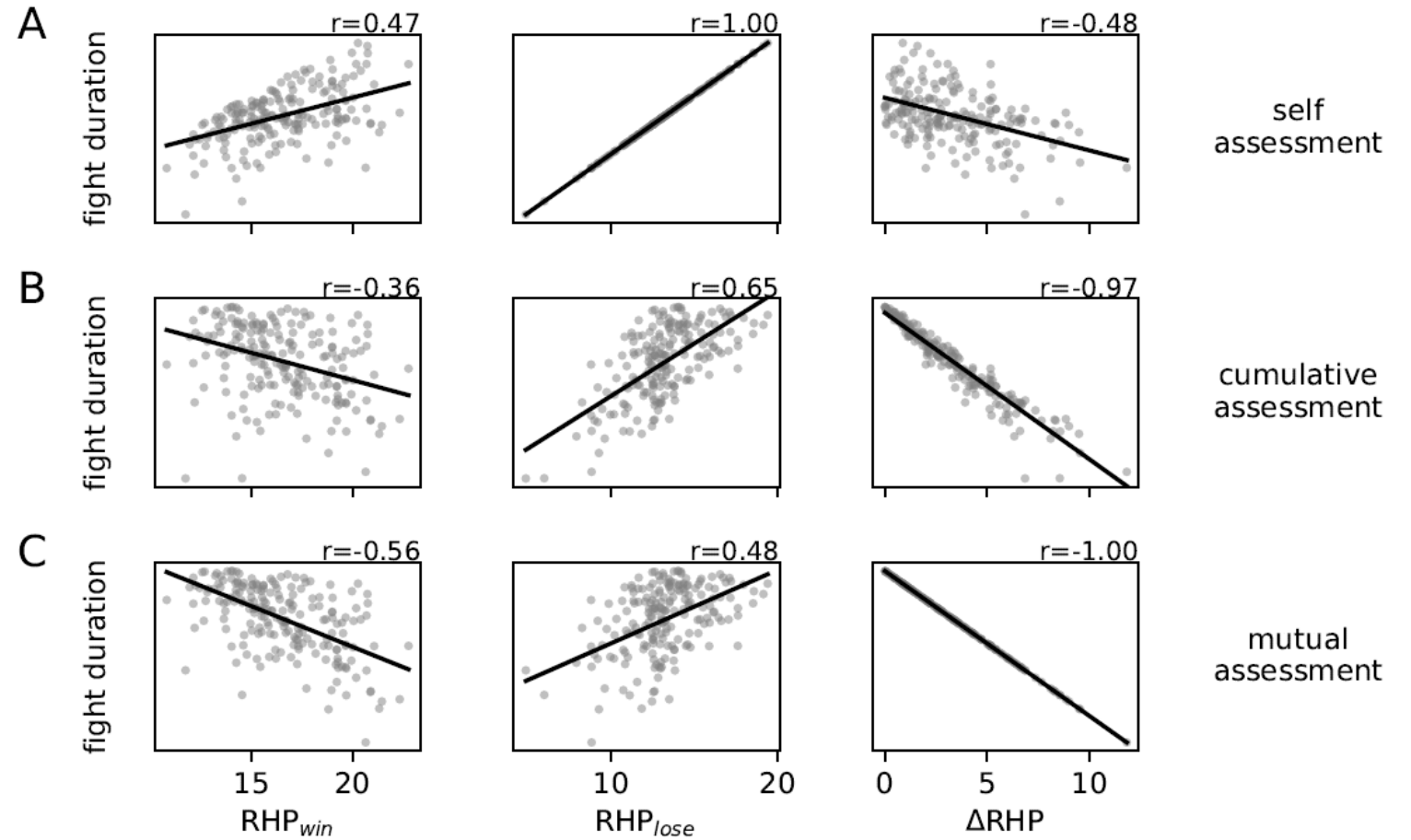
Estimate the effect of ...

... $\text{body-size}_{\text{win}}$

... $\text{body-size}_{\text{lose}}$

... $\Delta \text{body-size}$

on competition behavior across
assessment models.



Resource Holding Potential (RHP) ~ body-size

How to distinguish assessment models

Simulations

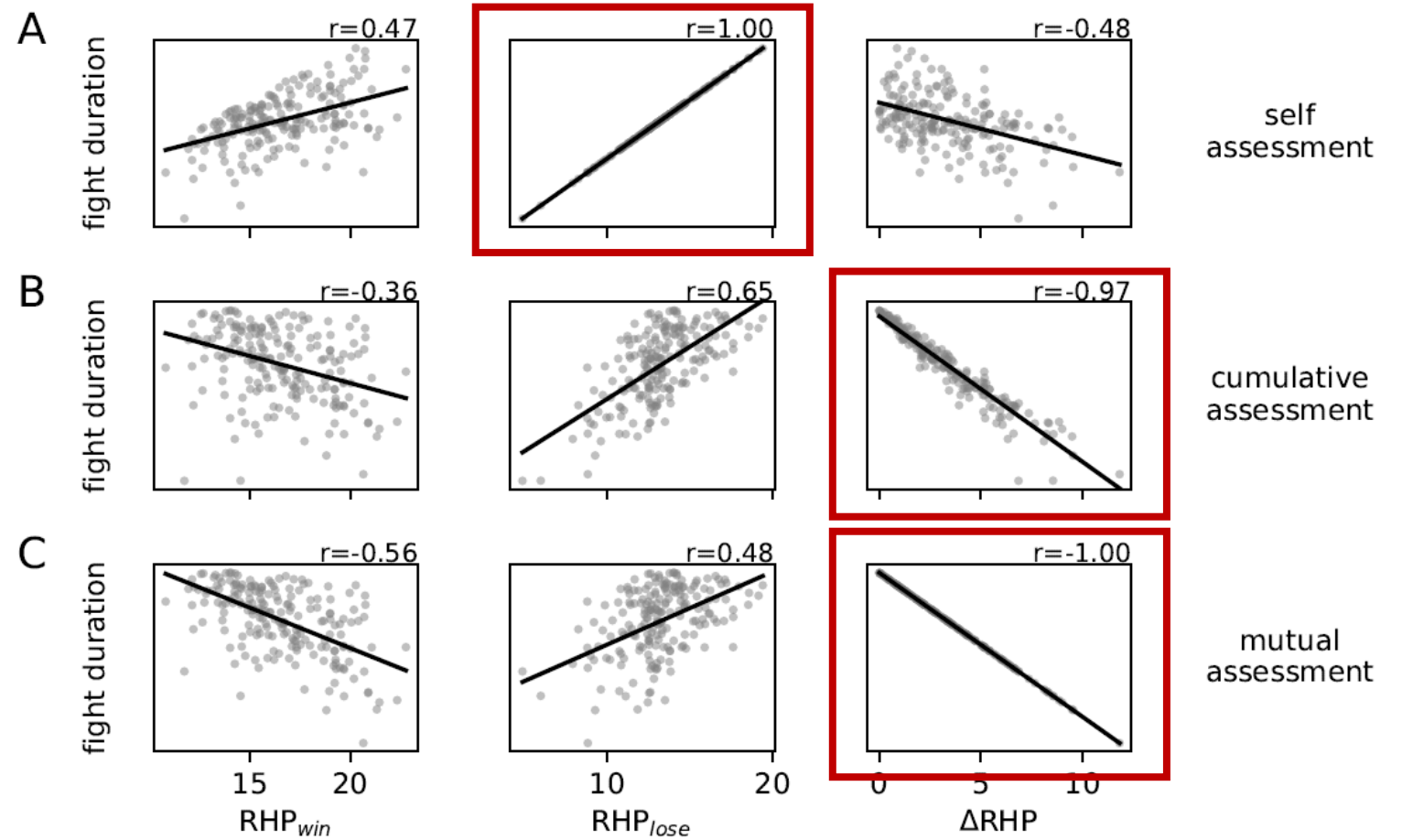
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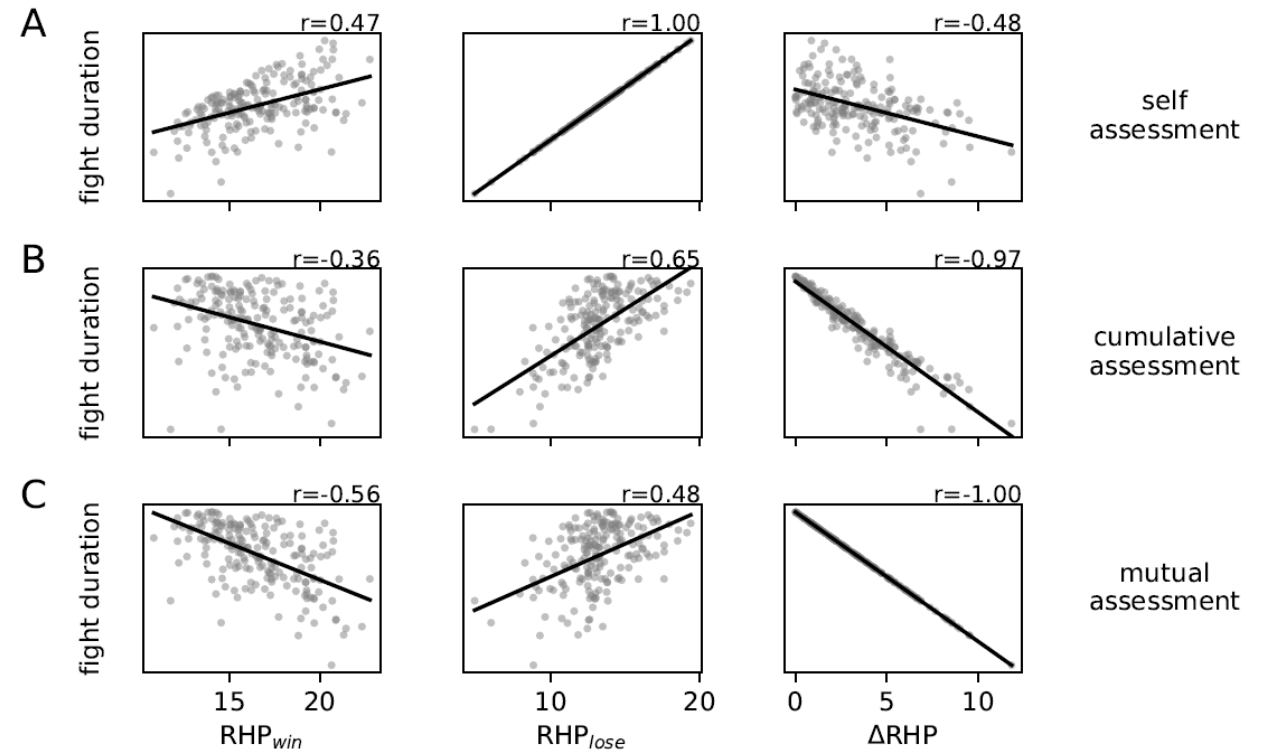
on competition behavior across
assessment models.



Resource Holding Potential (RHP) ~ body-size

How to distinguish assessment models

Rise count & chase duration

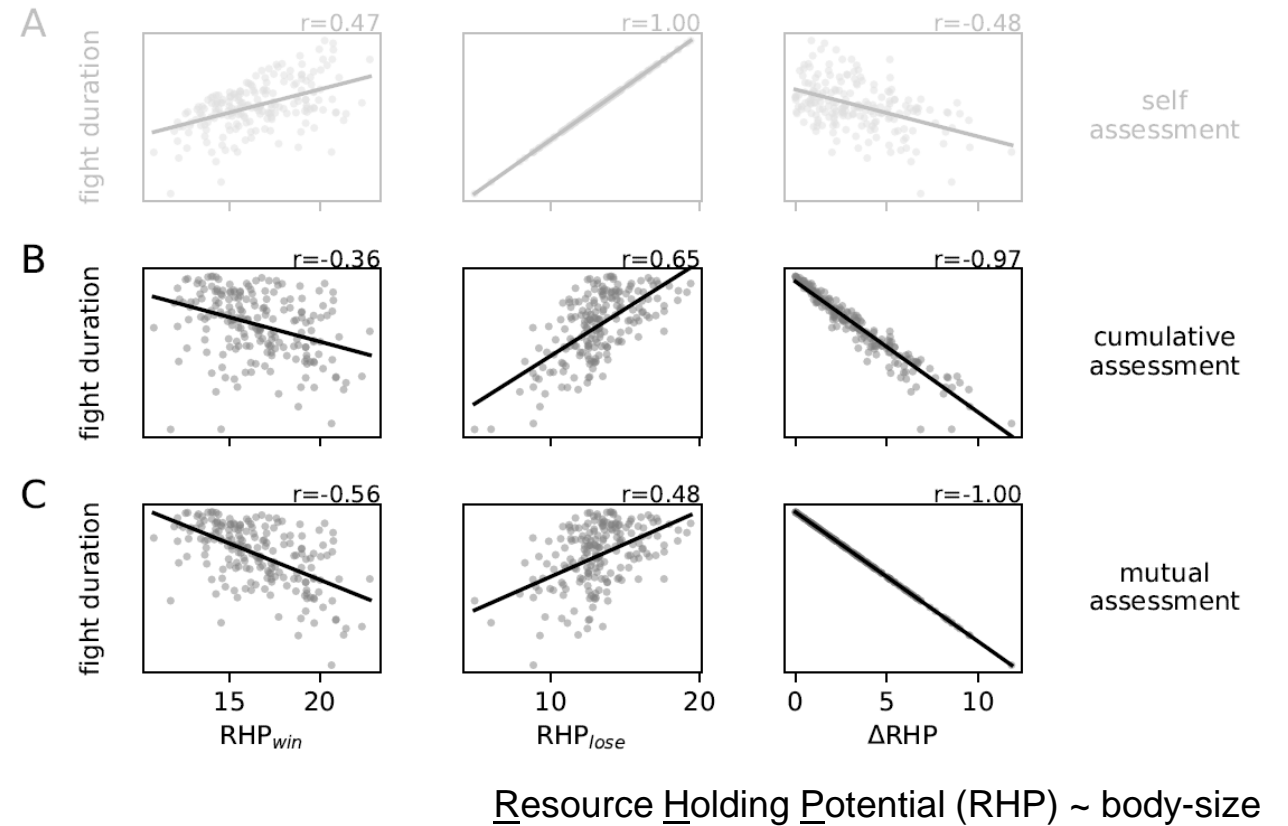
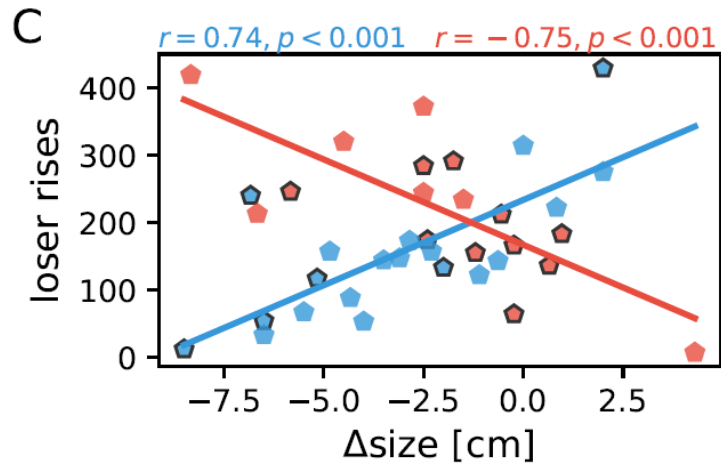


Resource Holding Potential (RHP) ~ body-size

How to distinguish assessment models

Rise count & chase duration

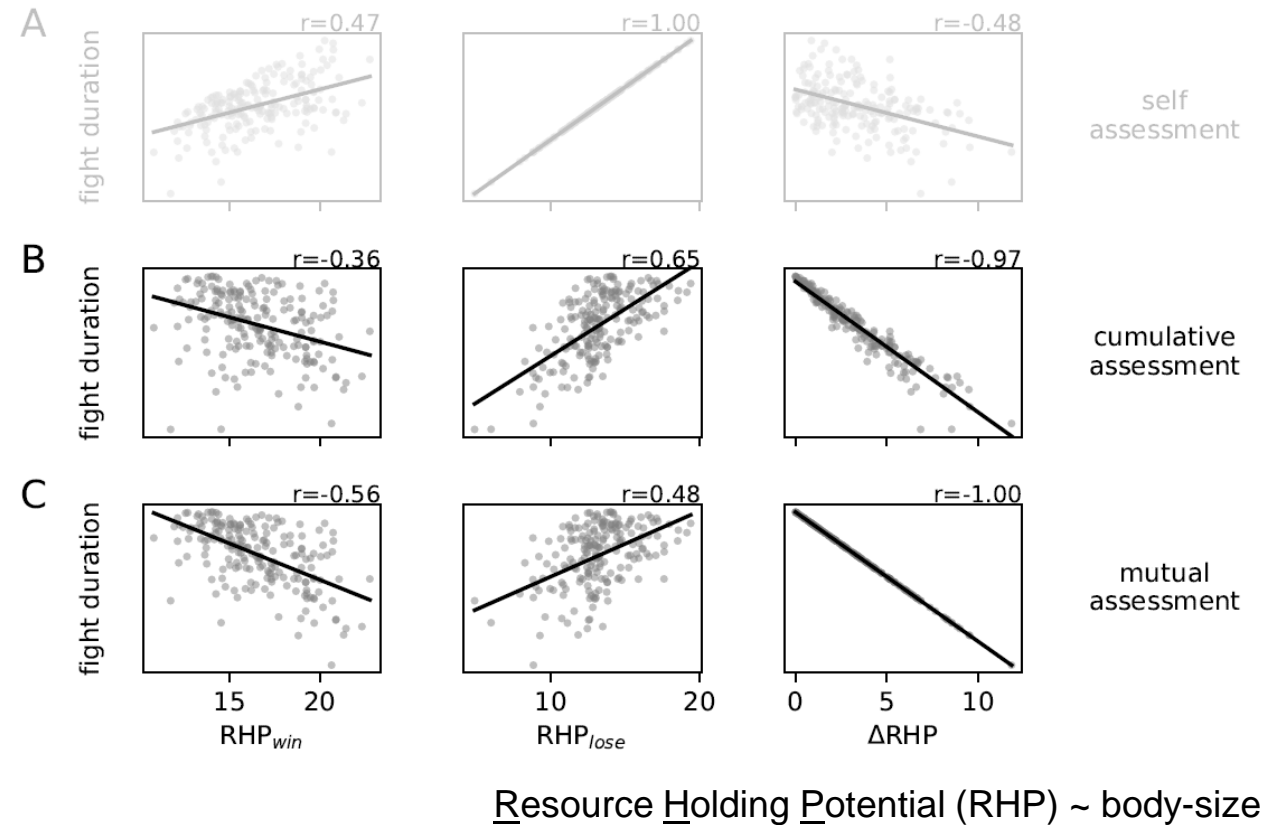
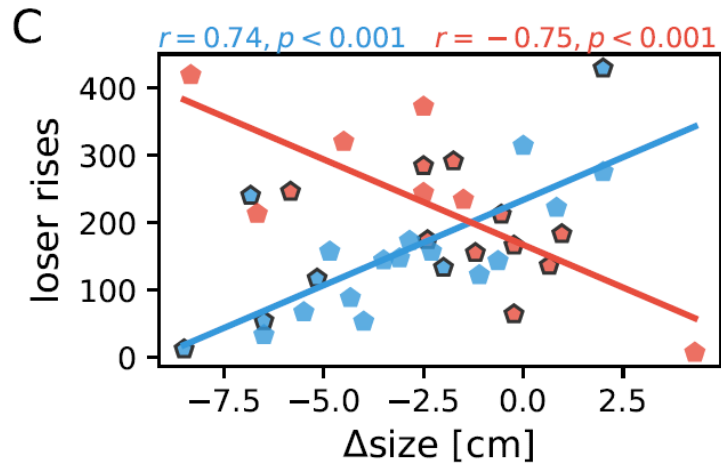
- unaffected by $\text{body-size}_{\text{win}}$
- unaffected by $\text{body-size}_{\text{lose}}$
- increase with $\Delta\text{body-size}$



How to distinguish assessment models

Rise count & chase duration

- unaffected by $\text{body-size}_{\text{win}}$
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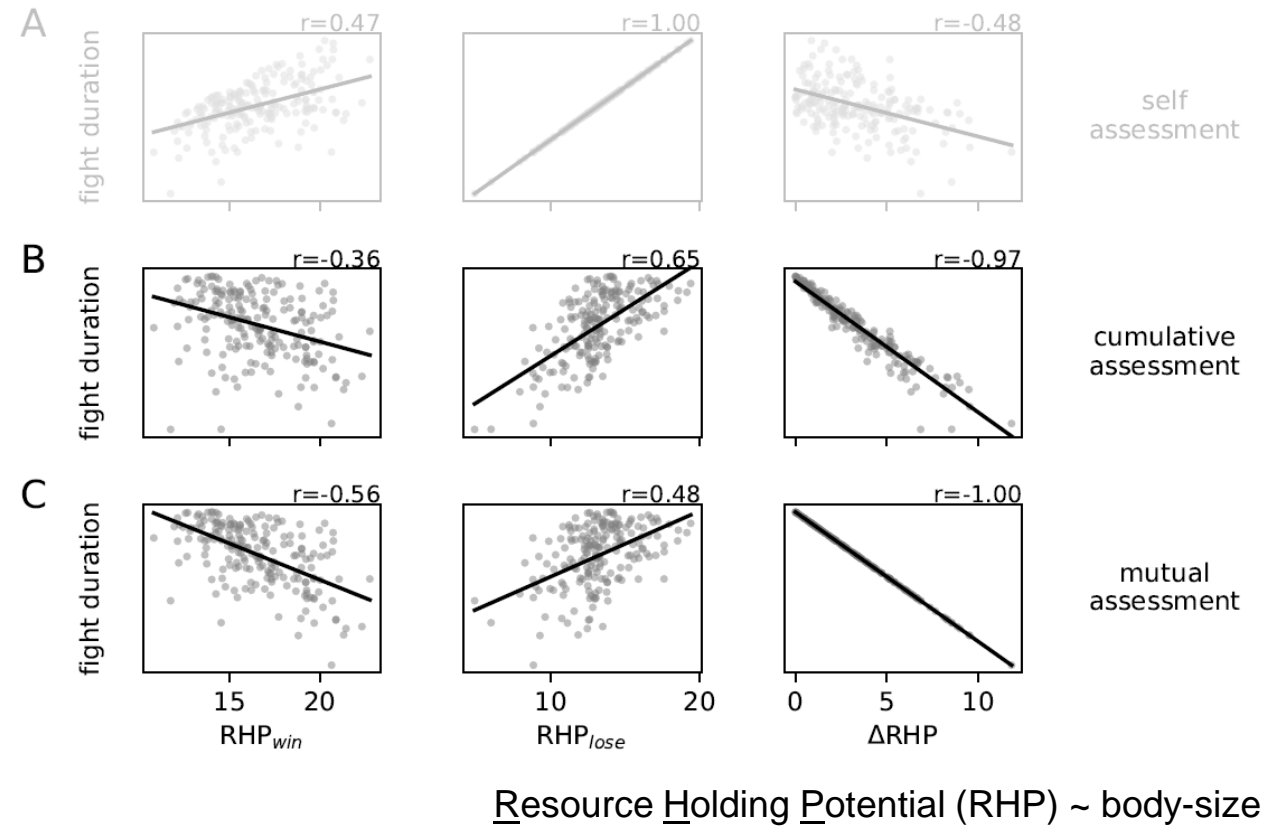
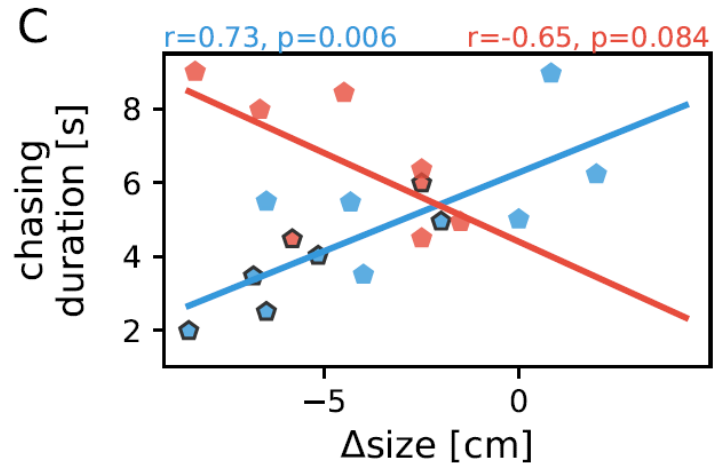


➡ ♂ losing against ♀ represent an exception

How to distinguish assessment models

Rise count & chase duration

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- unaffected by $\text{body-size}_{\text{lose}}$
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How to distinguish assessment models

Rise count & chase duration

- unaffected by $\text{body-size}_{\text{win}}$
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Fighting behavior

- Repetitive ritualized fighting



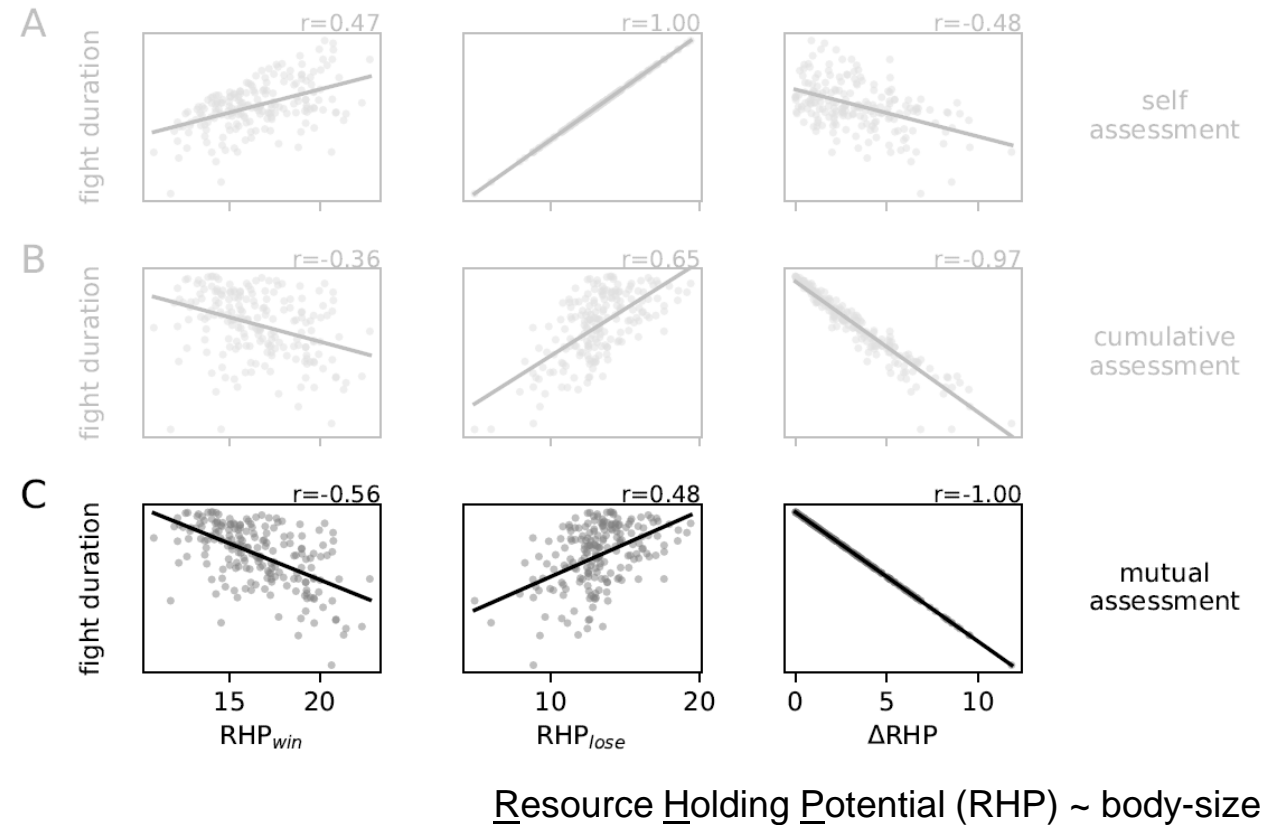
How to distinguish assessment models

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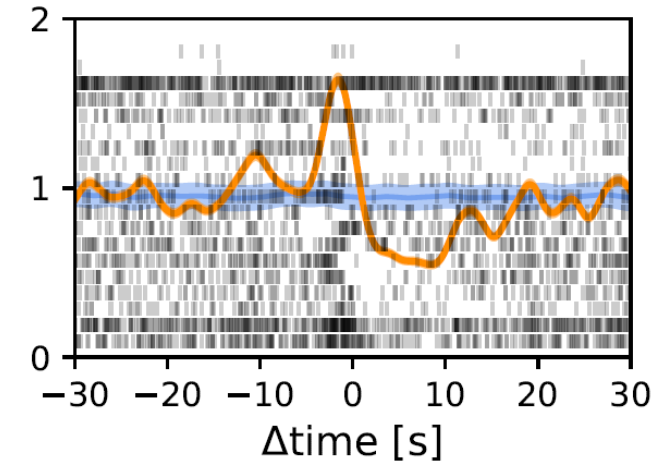
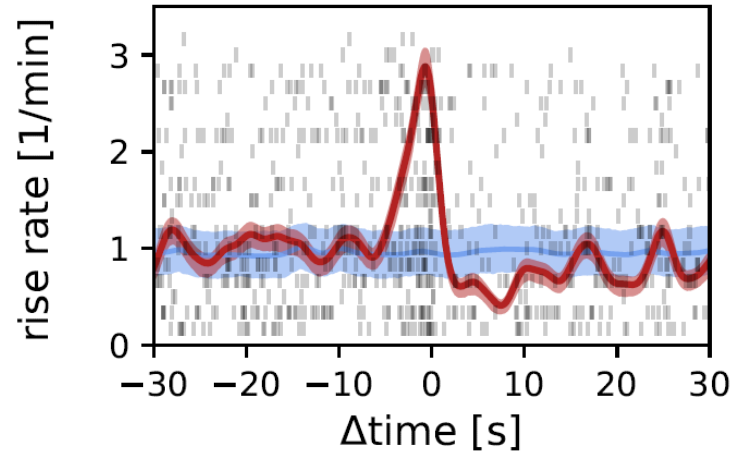


***A. leptorhynchus* use mutual assessment during competitions**

The function of rises during competitions

The function of rises during competitions

Rises
↓
agonistic interactions



The function of rises during competitions

Rises

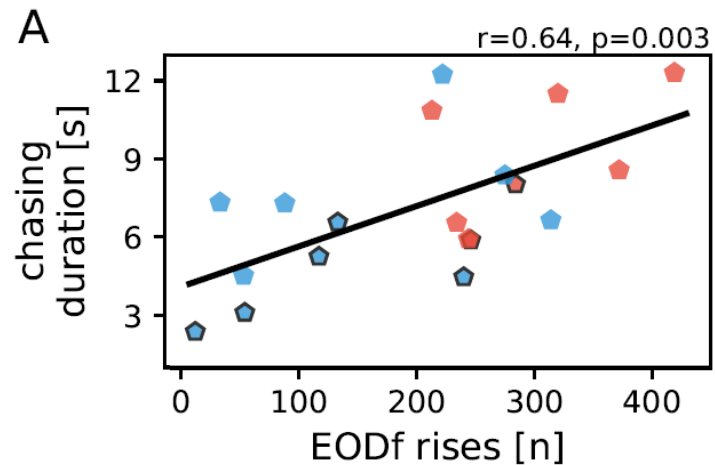
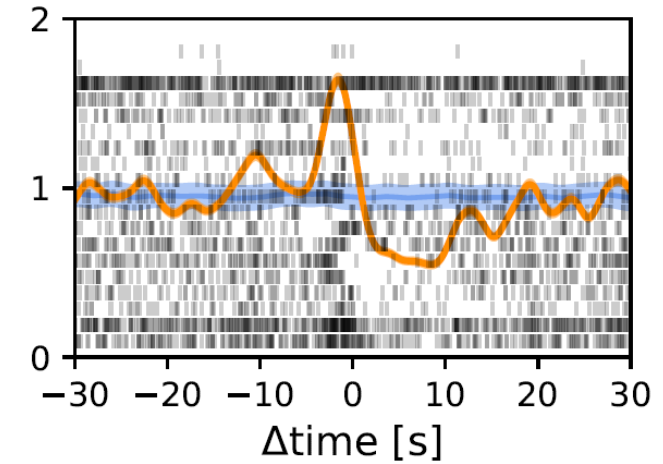
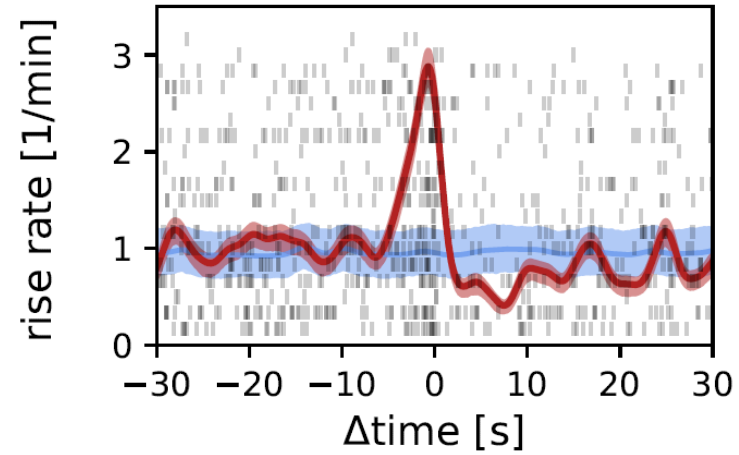


agonistic interactions

More Rises



longer chasing events

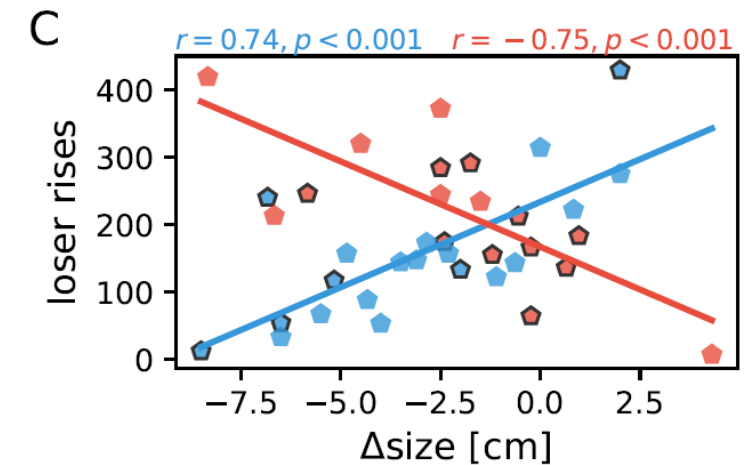
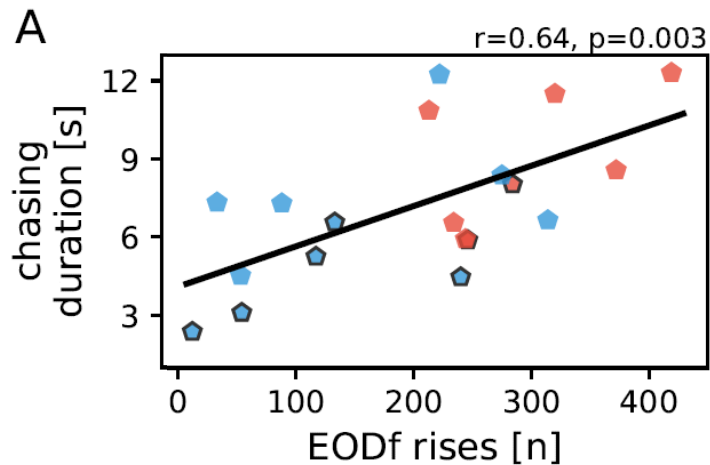
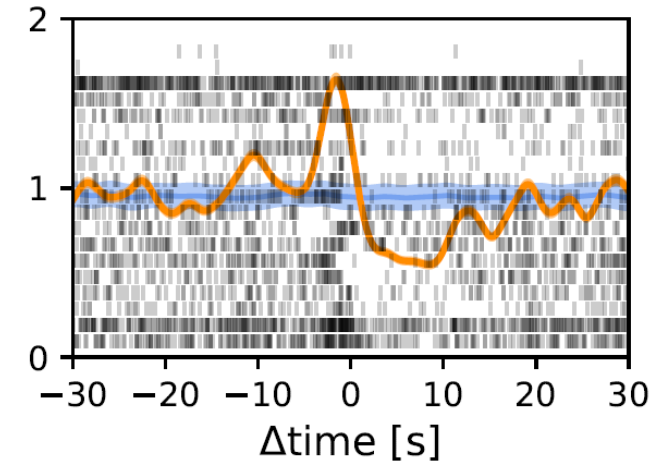
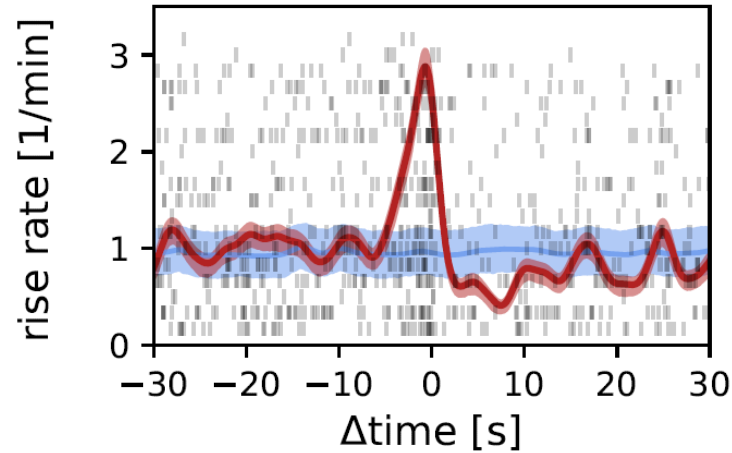


The function of rises during competitions

Rises
↓
agonistic interactions

More Rises
↓
longer chasing events

Smaller Δ body-size
↓
More rises

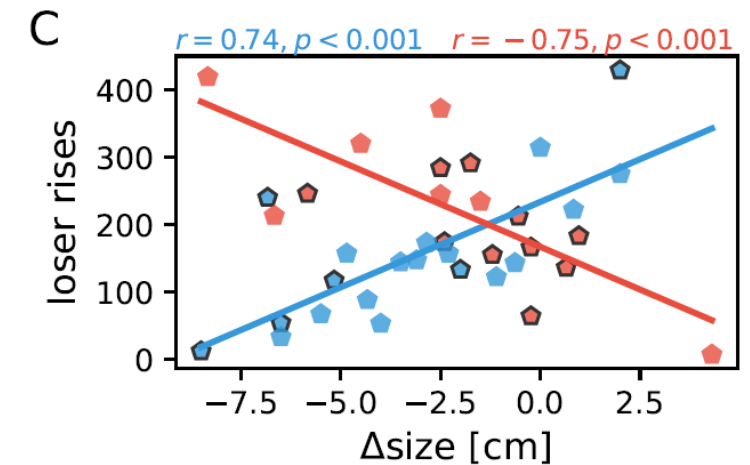
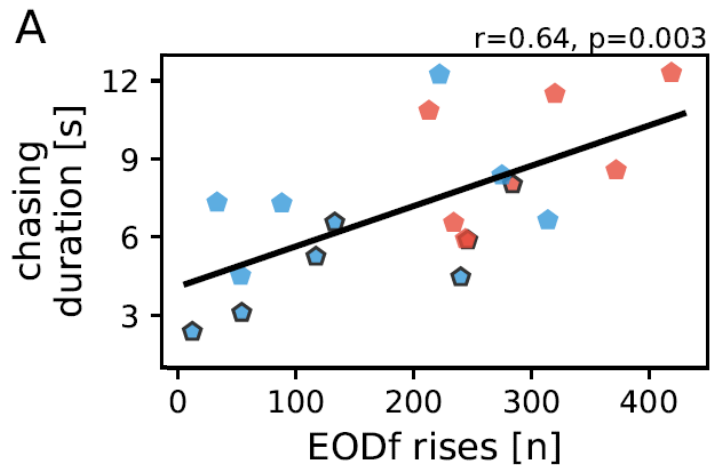
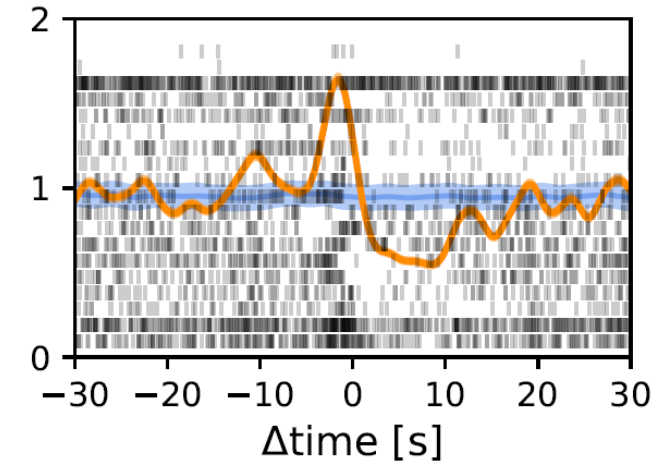
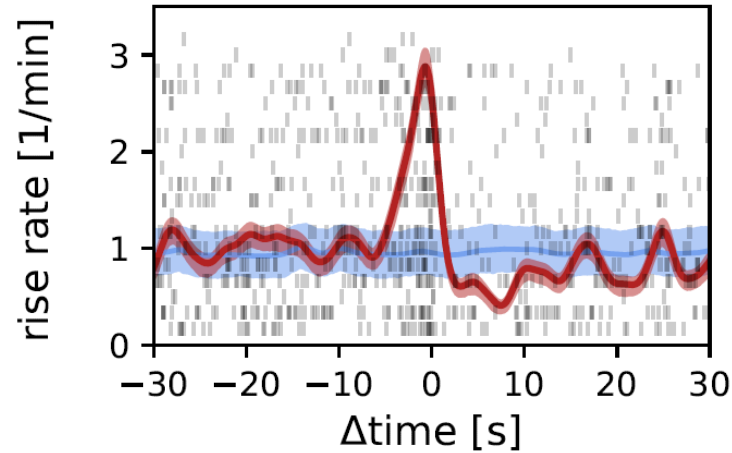


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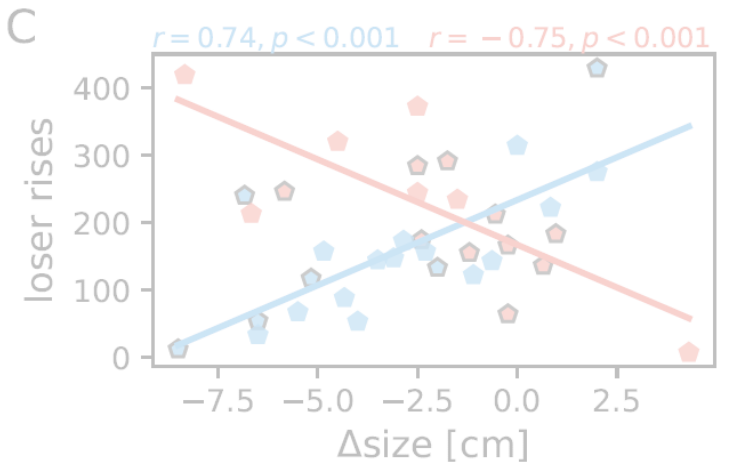
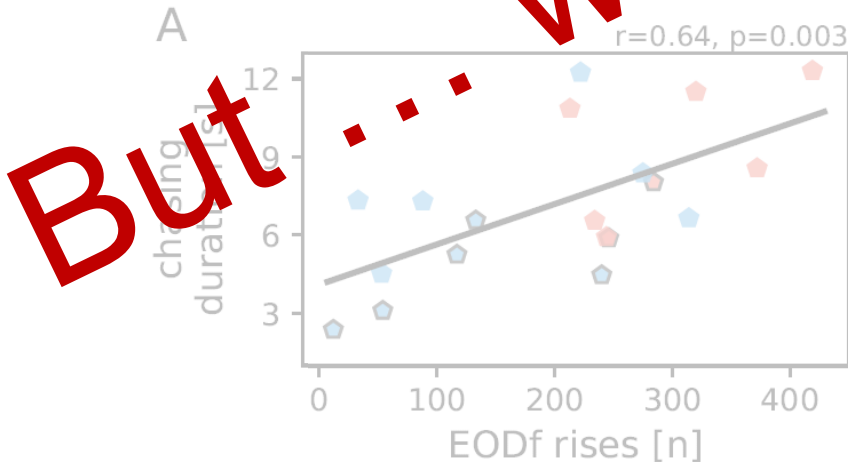
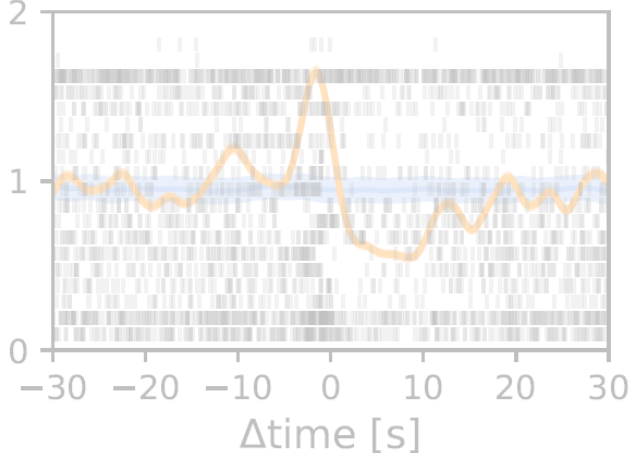
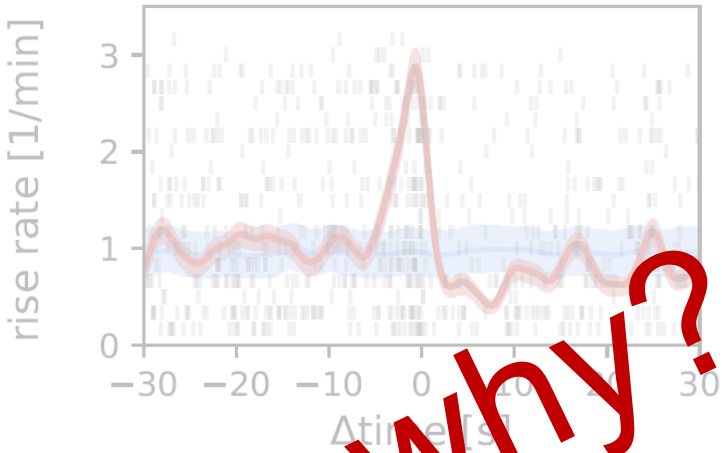
Rises as a signal of motivation during competitions

The function of rises during competitions

Rises
↓
agonistic interactions

More Rises
↓
longer chasing events

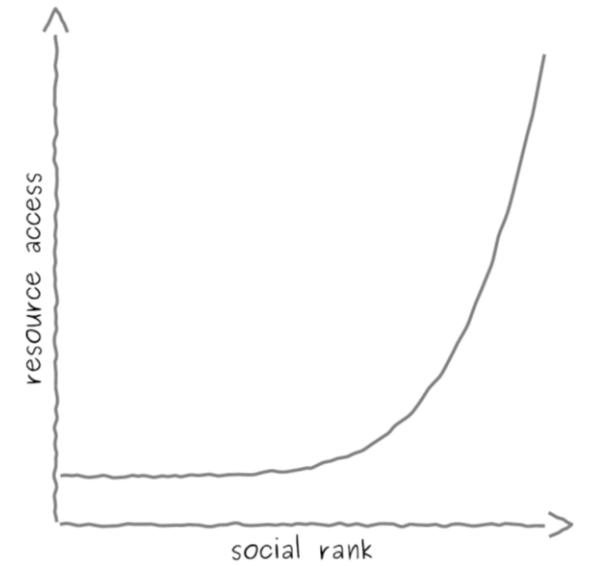
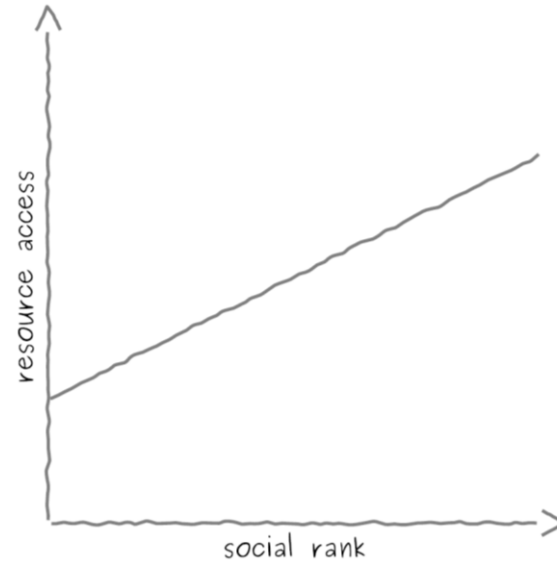
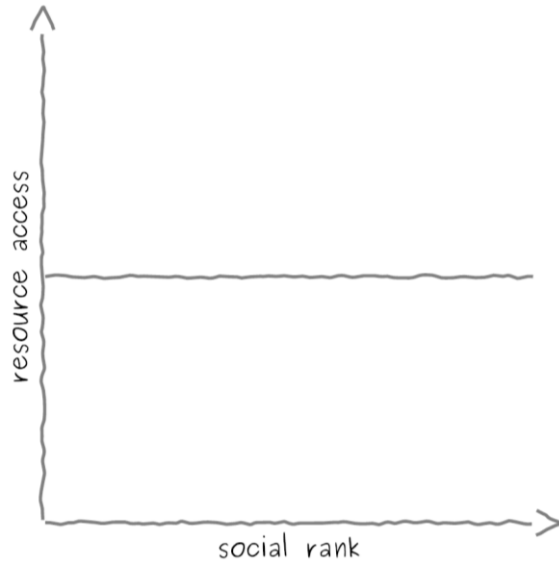
Smaller Δ body-size
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More rises



Rises as a signal of motivation

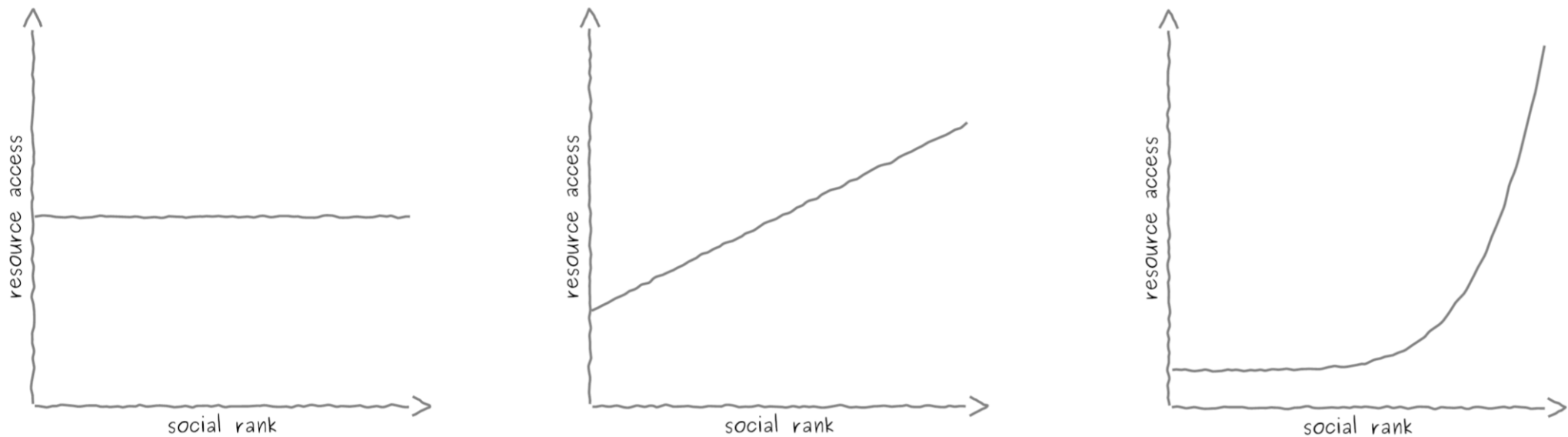
Organization of dominance hierarchies

egalitarian ←————→ despotic



Organization of dominance hierarchies

egalitarian ←————→ despotic

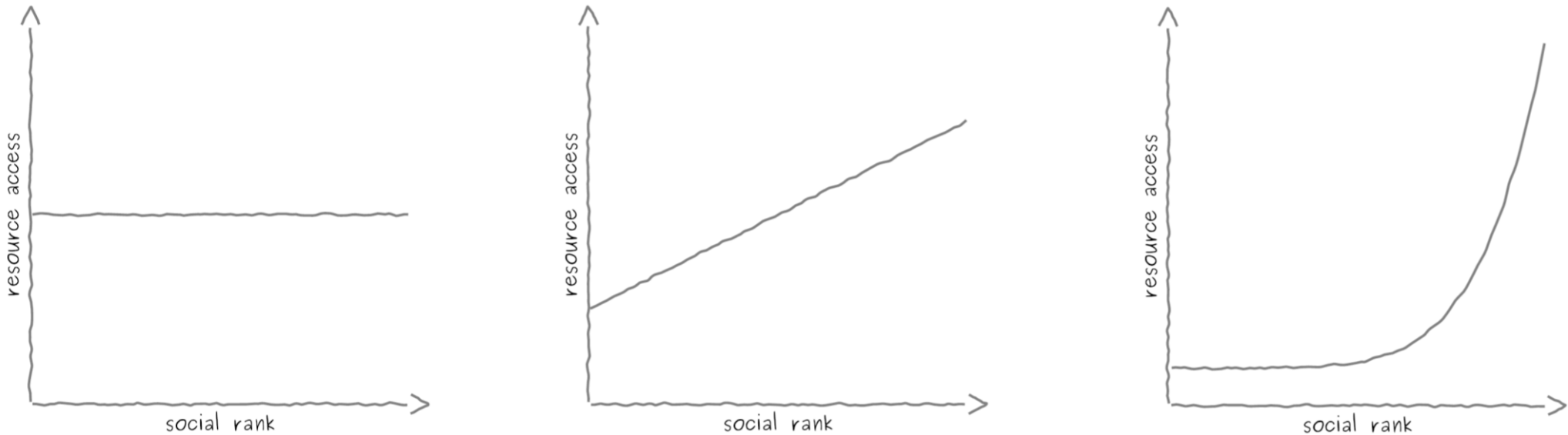


Significance
of social rank



Organization of dominance hierarchies

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Significance
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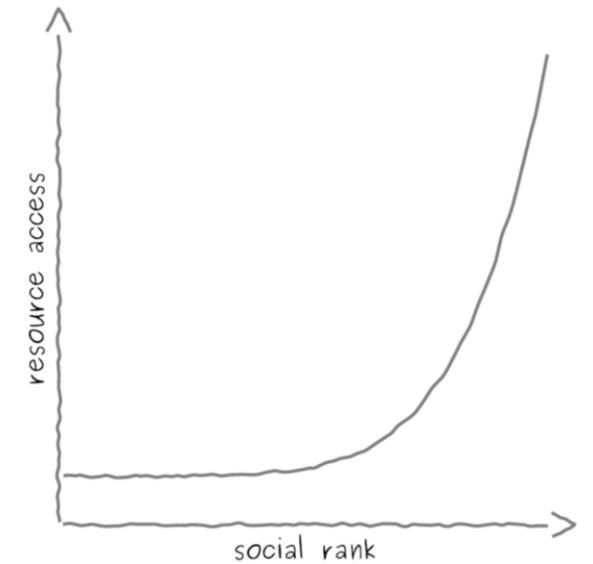
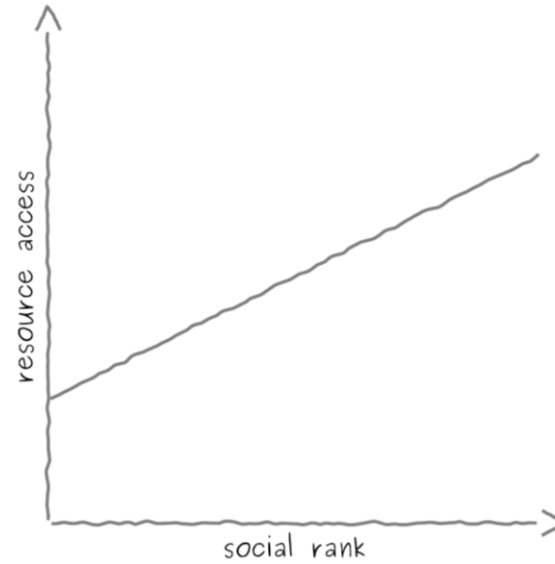
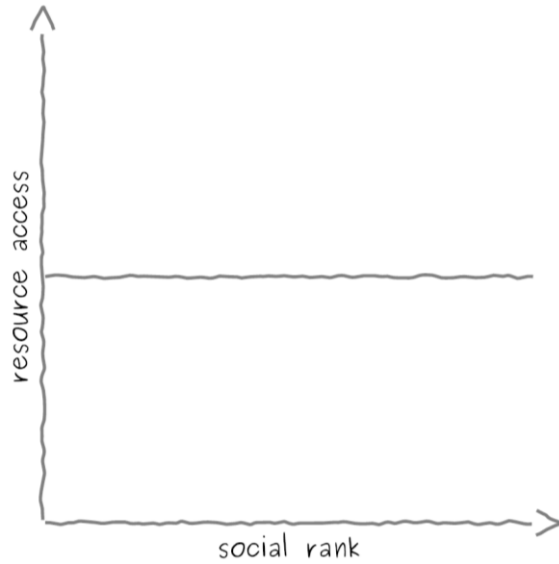


Resources



The dominance hierarchy in *A. leptorhynchus*

egalitarian ←————→ despotic

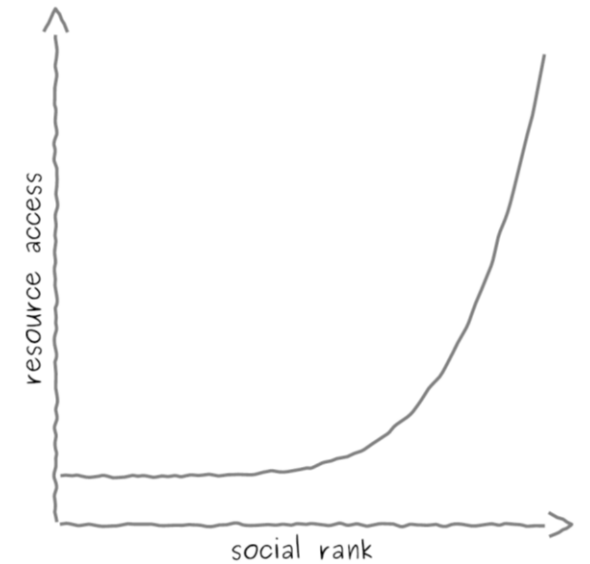
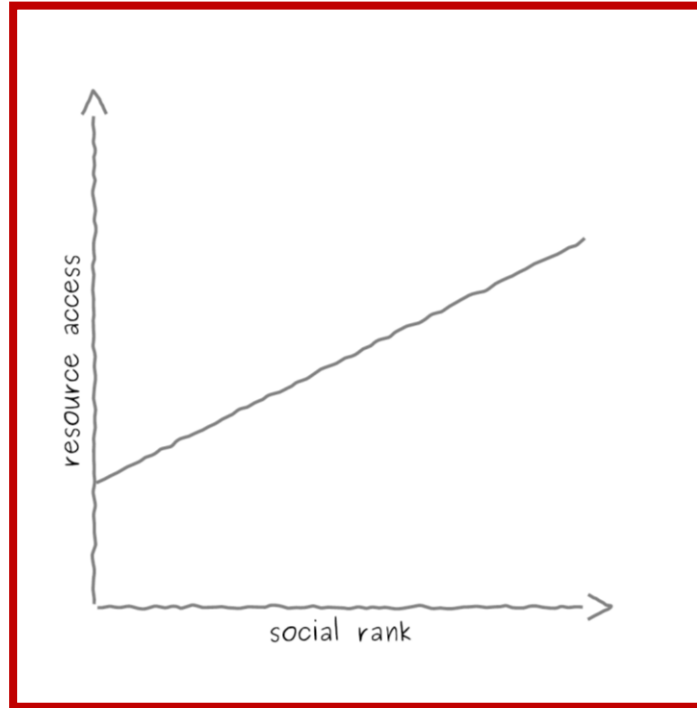
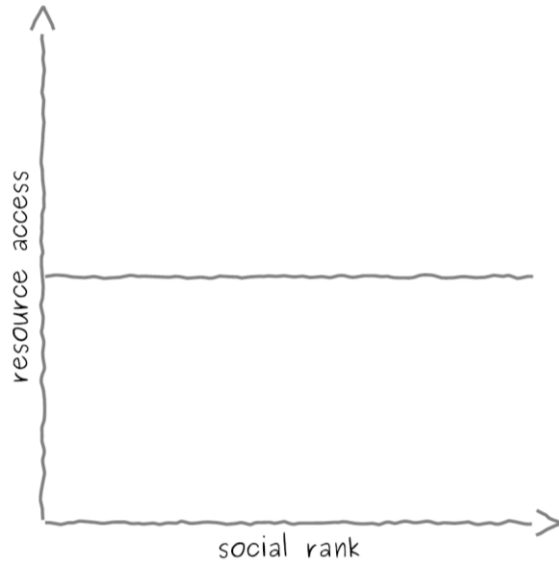


- Ritualized fighting to adjust skewness in access to resources

The dominance hierarchy in *A. leptorhynchus*

egalitarian

despotic

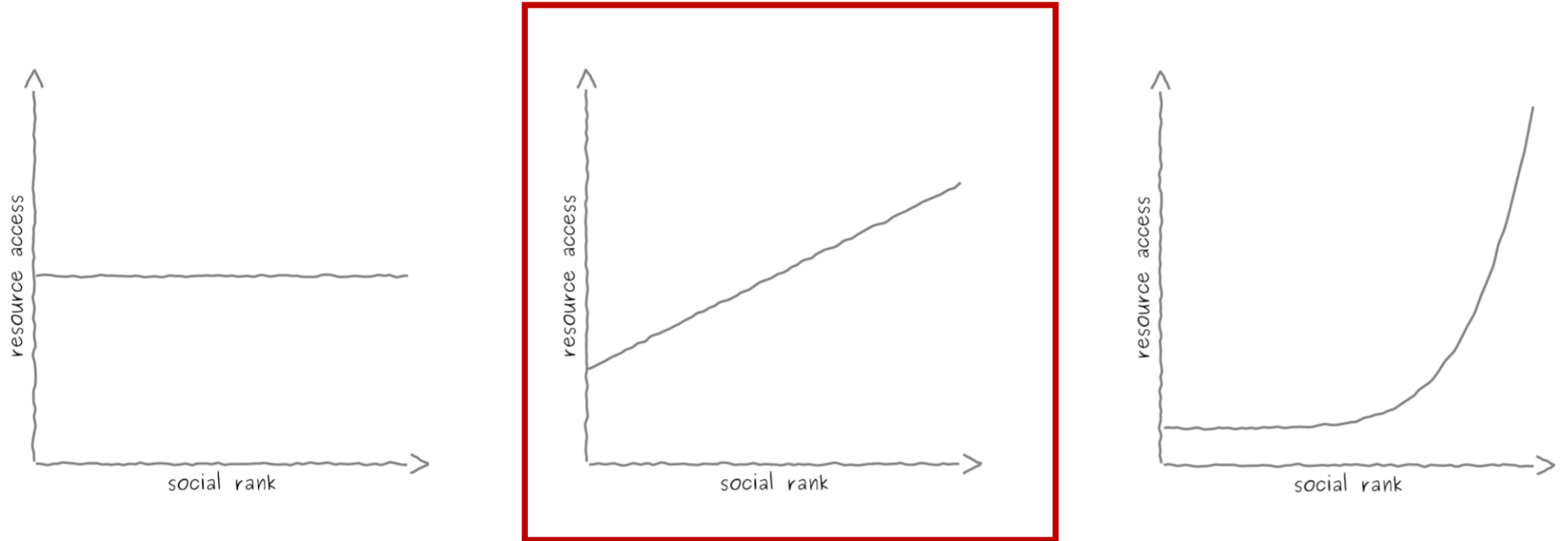


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The dominance hierarchy in *A. leptorhynchus*

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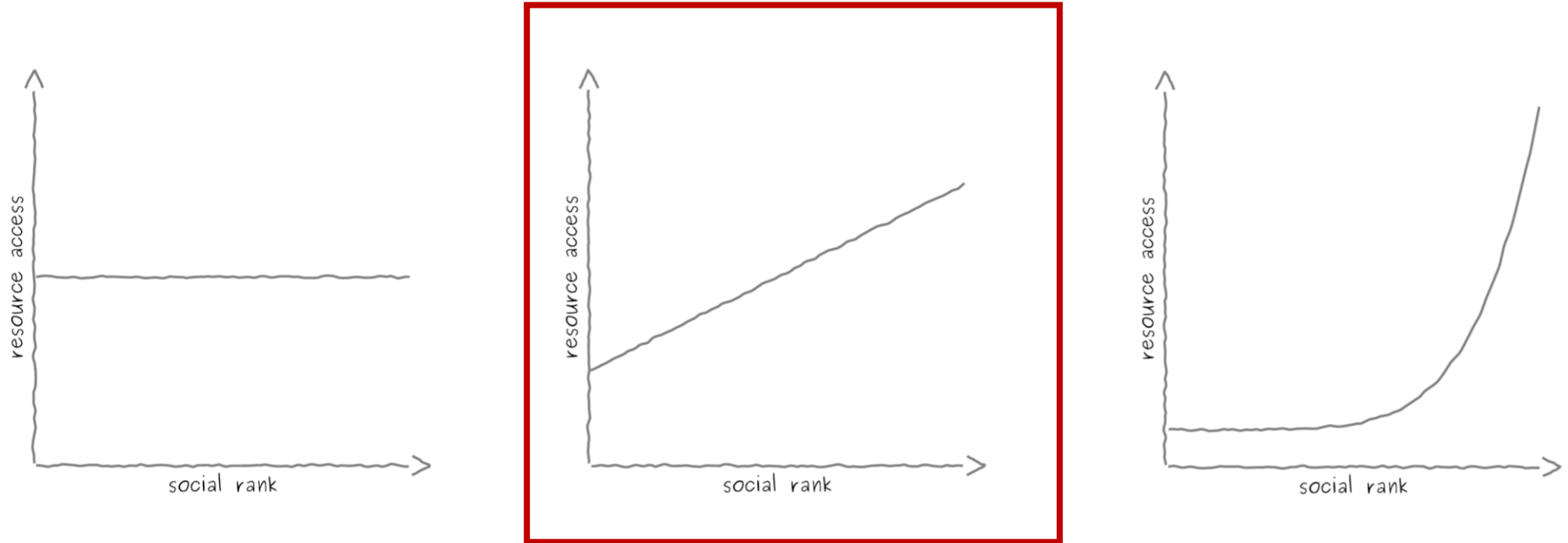


- Ritualized fighting to adjust skewness in access to resources
- Rises and agonistic interactions coordinate this process

The dominance hierarchy in *A. leptorhynchus*

egalitarian

despotic

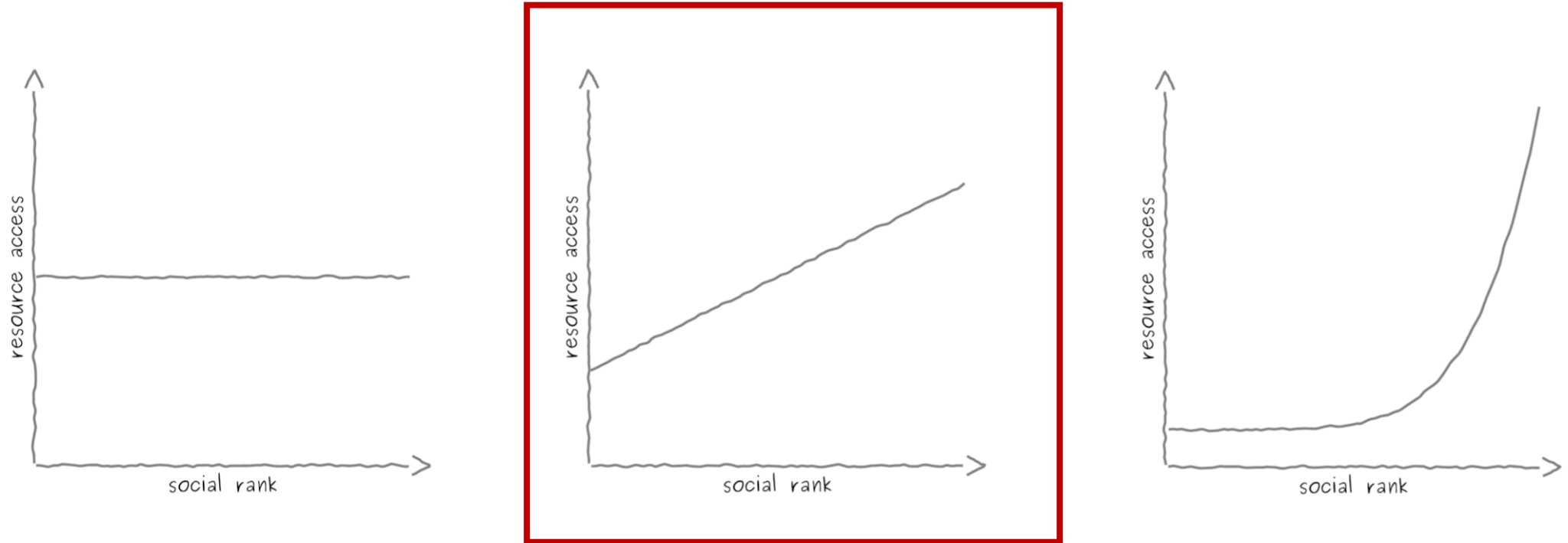


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- Increased resource valuation in males could explain deviating behavior

The dominance hierarchy in *A. leptorhynchus*

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despotic



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