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You eat what you are: personality-dependent filial cannibalism in a fish with paternal care

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Filial Cannibalism

A taboo in human society

The famous painting:Saturno devorando a su hijo.

A Chinese saying：“虎毒不食子”

Common and widespread in animals

Adaptive Hypotheses on Filial Cannibalism

Adaptive hypothesis	Description	General prediction	Prediction for offspring-specific cannibalism	Example publications
Parental energy reserves	Parents use cannibalism to manage their onboard energy reserves	Low energy reserves: ↑ FBC and PBC	—	Rohwer (1978); Sargent (1992); Sargent *et al.* (1995); Manica (2002)
Brood size	Small broods may not be worth the parental effort to raise them. Individual offspring from large broods are less costly to consume	Small brood size: ↑ FBC Large brood size: ↑ PBC	—	Rohwer (1978); Sargent (1992); Sargent *et al.* (1995); Manica (2002)
Brood parentage	Broods containing non-kin offspring may not be worth the parental effort to raise them. Consuming non-kin offspring incurs fewer inclusive fitness costs	Low/uncertain parentage: ↑ FBC and PBC	Non-kin offspring should be selectively consumed based on perceived parentage cues	Neff & Sherman (2002); Neff (2003); Manica (2004)
Mate availability	Costs of cannibalism are lower when offspring can be replaced quickly and efficiently	High re-mating probability: ↑ FBC and PBC	—	Okuda & Yanagisawa (1996*b*); Kondoh & Okuda (2002); but see Deal & Wong (2016)
Brood density	Cannibalism is used to reduce offspring overcrowding	High offspring density: ↑ FBC and PBC	—	Payne, Smith & Campbell (2002); Klug, Lindström & St Mary (2006)
Brood survival prospects	Cannibalism is used to remove offspring with low odds of survival	Low survival probability: ↑ FBC and PBC	Weakest offspring should be selectively consumed	Forbes & Mock (1998); Huang (2008); Chin-Baarstad, Klug & Lindström (2009)
Non-viable offspring and brood hygiene	Consuming dead offspring incurs no inclusive fitness costs. Cannibalism is used to remove offspring that are likely to spread disease in a brood	Presence of non-viable (dead) offspring: ↑ FBC and PBC	Dead or diseased offspring should be selectively consumed	Kraak (1996); Lehtonen & Kvarnemo (2015*a*, *b*); Okada *et al.* (2015)

Given that all hypotheses either lack empirical evidence or have produced inconclusive results, filial cannibalism still constitutes an evolutionary conundrum.

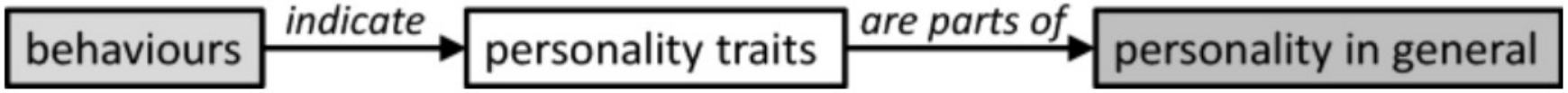
Personility influence:intrinsic rather than extrinsic

extrinsic:
environmental conditions

vs

intrinsic:
animal personility

Fig. 1



Relationship between behaviours, personality traits and personality in general

Behavioral Syndromes

- multiple behaviors form population-wide intrinsic correlations,which lead to limited behavioral plasticity.
- female fishing spiders, *Dolomedes triton,* with high voracity levels

  beneficial in ontogeny ;

  reduced reproductive success due to excessive precopulatory sexual cannibalism

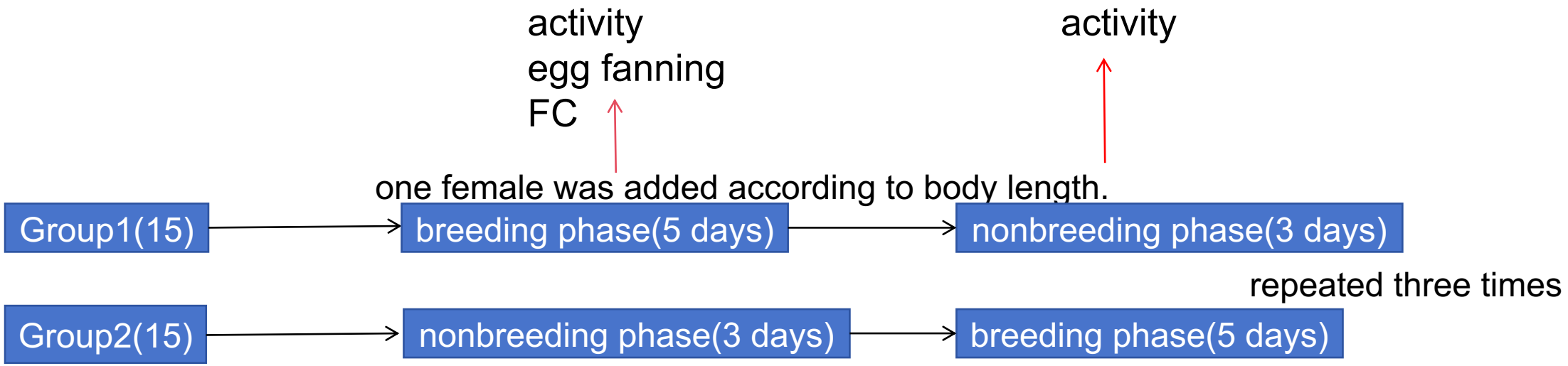
Hypothesis

- Using the common goby (Pomatoschistus microps, Krøyer) as a model system,two experiments are designed to test:
- 1)whether filial cannibalism is connected with other individual behaviors ,such as activity and egg fanning during paternal care.
- 2)whether fish allocated into groups based on previously established personality scores subsequently show predictable amounts of egg cannibalism.

Figure 1. A male common goby (*Pomatoschistus microps*).

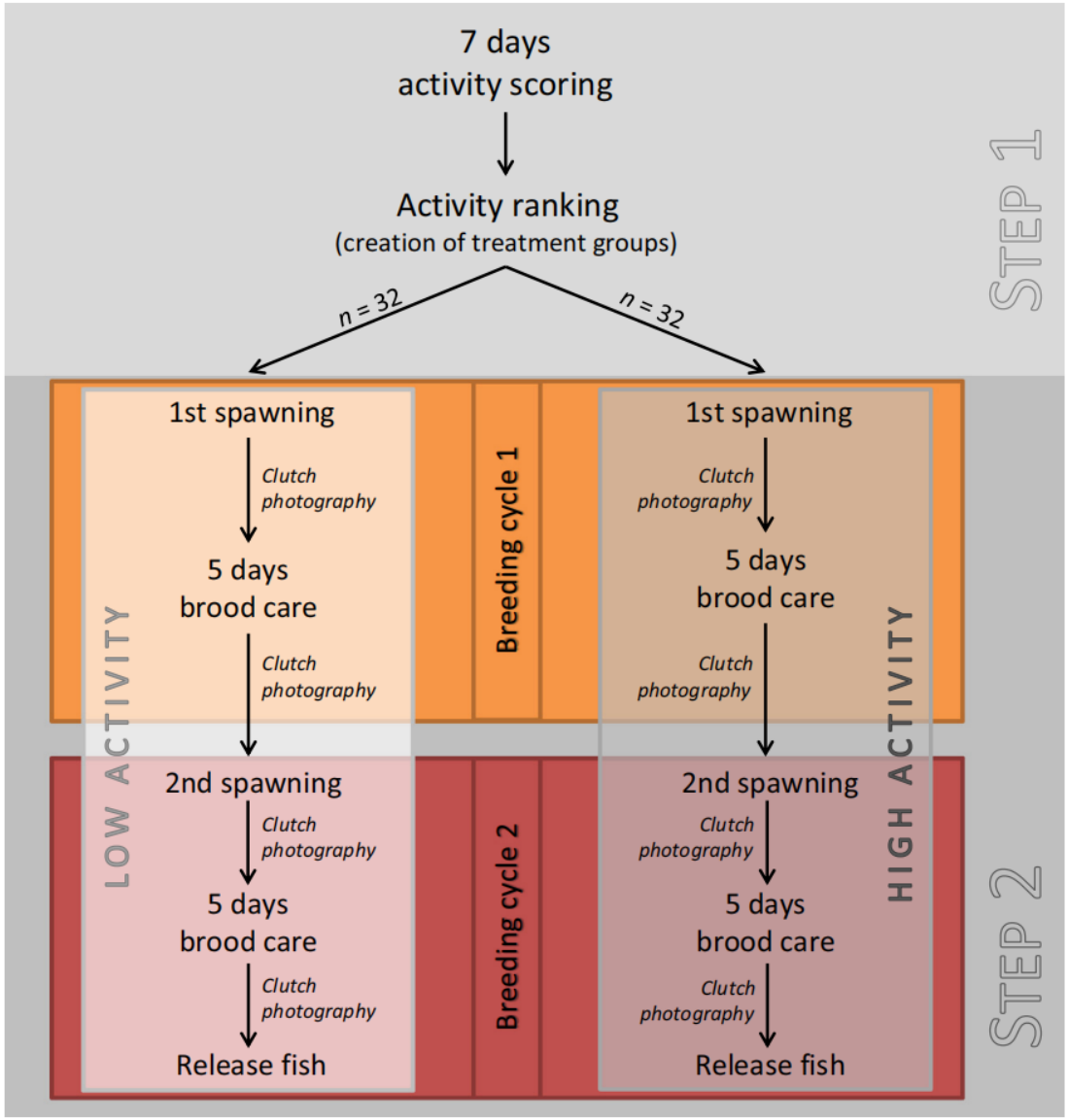
Experiment 1

- Activity: the number of pectoral movements resulting movement during 180 sec(subtracted periods of egg guarding).
- Egg fanning:the number of pectoral fin flaps per time the male spent in fanning position.
- FC :the number of eggs eaten per day;whole clutch FC are analyzed separately.



Experiment 2

- Males are allocated to a low-activity and a high activity group
- Two breeding cycles in simulated natural seasonal changes for FC measuring.



RESULTS

- Active individuals tending to consume more eggs.
- No behavioral syndromes linking the paternal care traits egg fanning

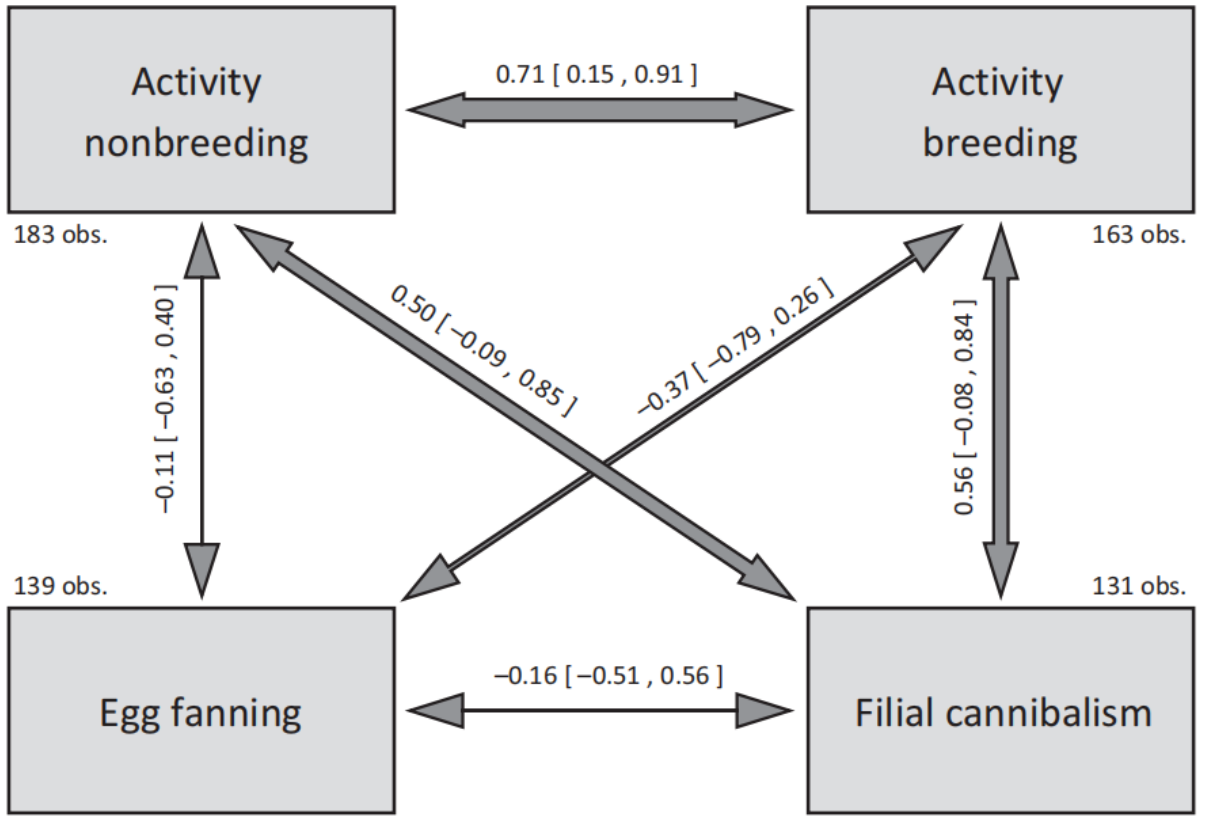


Figure 4. Behavioral correlations represented by correlation coefficients and their corresponding 95% credible intervals as estimated by a multiple-response MCMC model (n = 131–183 observations of 23 individuals; number of observations for each behavior given in figure). Credible intervals not crossing zero identify significant correlations. Arrow thickness indicates the strength of the correlation.

RESULTS

- Breeding cycle and activity have significant effect on the number of eggs eaten.
- significant interaction between activity and breeding cycle.

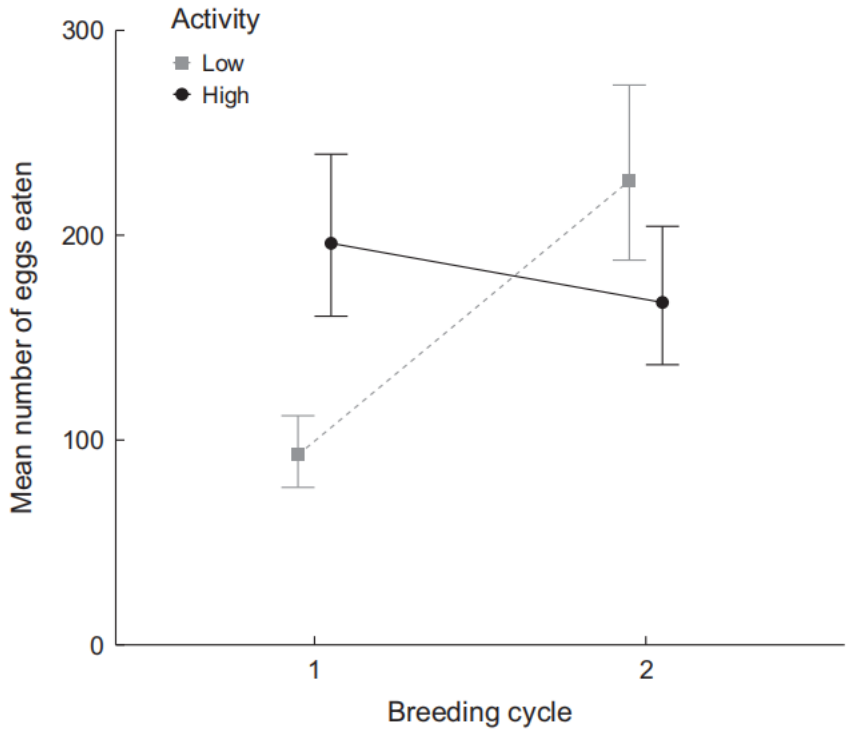


Figure 6. Interaction plot based on model estimates for the mean absolute number of eggs cannibalized per fish (excluding cases of TFC). Presented are group means and standard errors for each factor combination of activity and breeding cycle.

Table 1. Fixed effect estimates from a generalized linear mixed model with Poisson error structure and individual as random effect. The model evaluated the effect of activity (low or high) and breeding cycle (1 or 2) on the number of eggs cannibalized by common goby males (n = 60 observations of 43 individuals). Note that estimates are on the log scale.

	Estimate	SE	z-value	P
Intercept	4.30	0.25	17.53	<0.001
Activity	0.81	0.37	2.20	0.028
Breeding cycle	1.16	0.36	3.20	0.001
Activity × Breeding cycle	−1.38	0.54	−2.55	0.011

RESULTS

FC

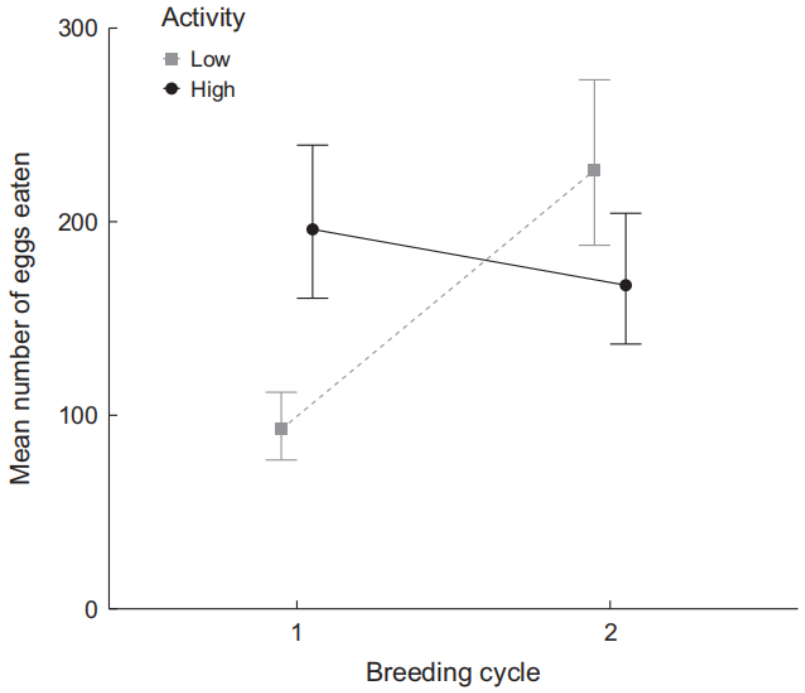
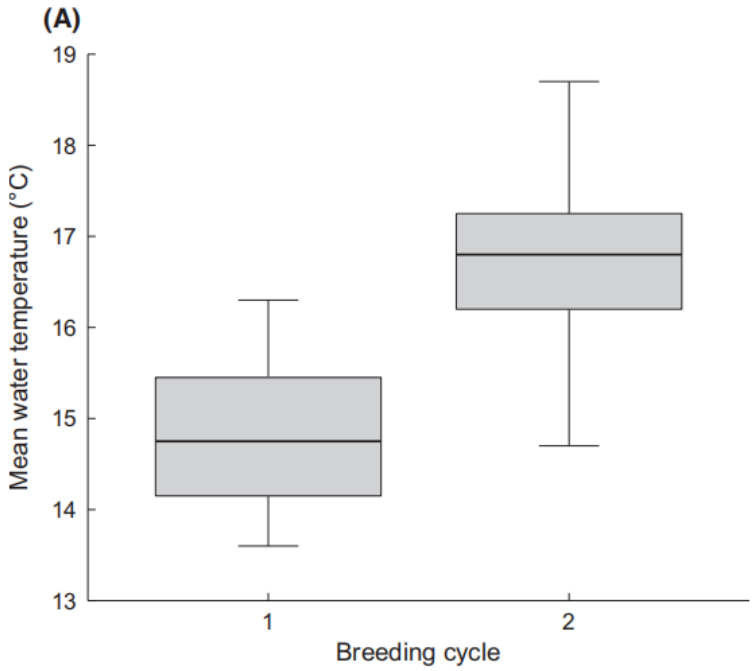


Figure 6. Interaction plot based on model estimates for the mean absolute number of eggs cannibalized per fish (excluding cases of TFC). Presented are group means and standard errors for each factor combination of activity and breeding cycle.

Water Temperature



Clutch Size

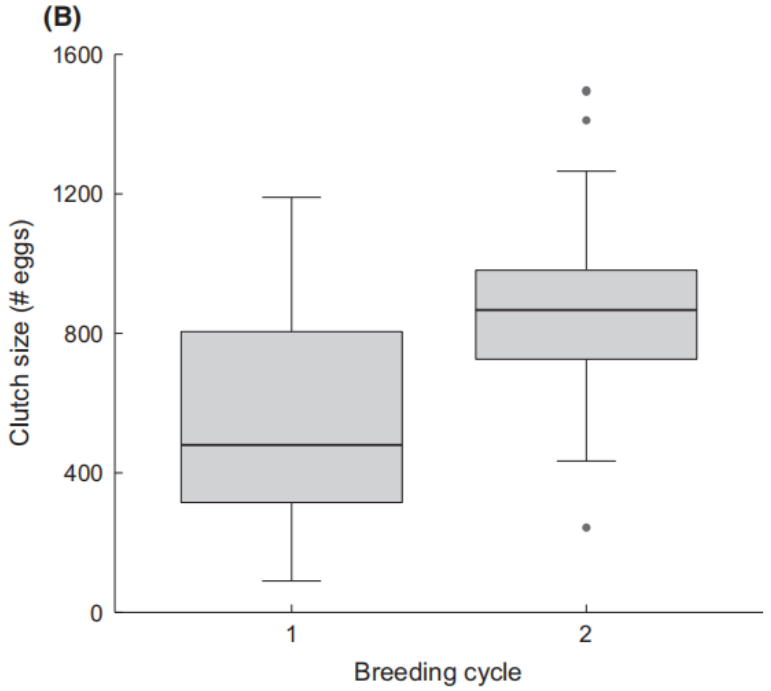


Figure 3. Differences between breeding cycles (n_1 = 49, n_2 = 45) in (A) mean water temperature per male and (B) clutch size.

RESULTS

Total filial cannibalism covaried with clutch size (z = - 3.09,P = 0.002),but not activity (z = - 0.37, P = 0.714, n = 94 observations of 50 individuals)

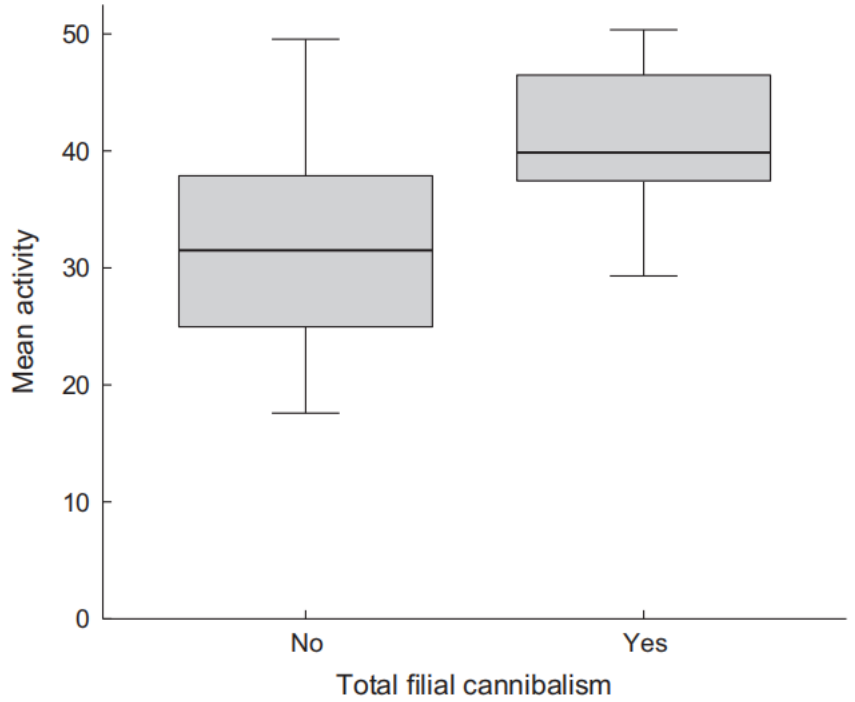


Figure 5. Difference in overall activity (mean of both contexts) between males that never showed total filial cannibalism (TFC_{no}; n = 16) and males that fully cannibalized at least one of their clutches (TFC_{yes}; n = 7).

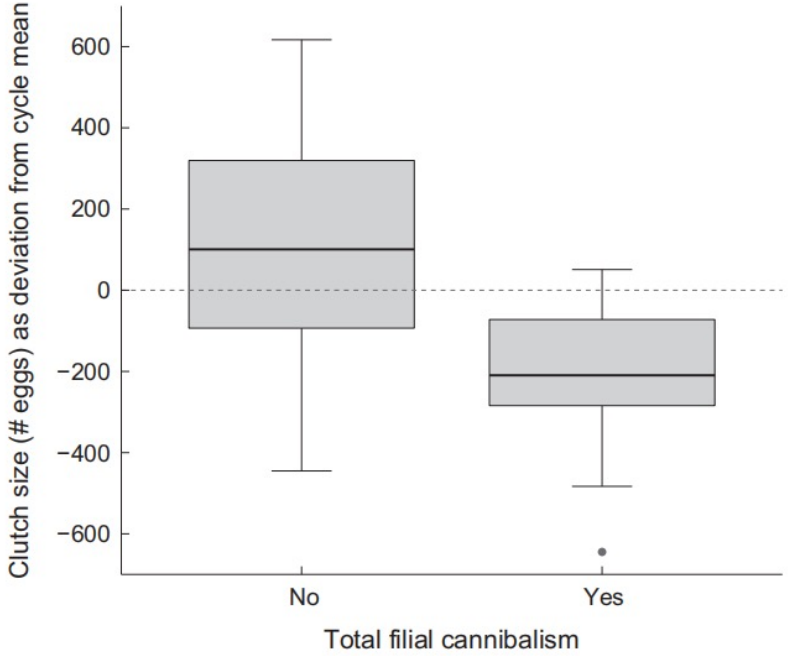
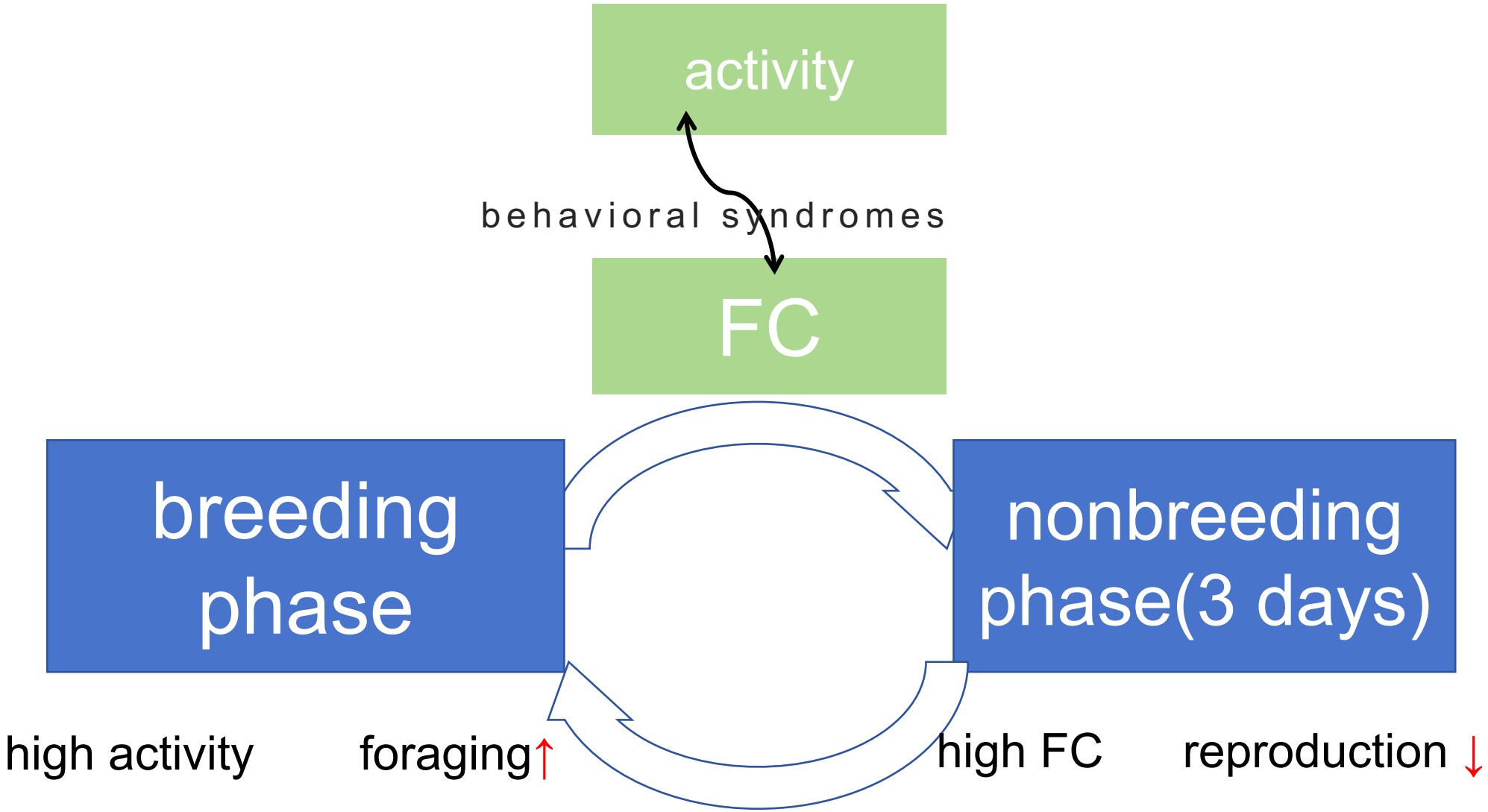


Figure 7. Difference in the original number of eggs between clutches that were fully cannibalized (TFC_{yes}; n = 34) and clutches that were not (TFC_{no}; n = 60). Values were centered on the mean of the corresponding breeding cycle, and deviations from zero thus indicate that clutches were larger or smaller than average within their cycle.

Discussion


activity
behavioral syndromes
FC
breeding phase
nonbreeding phase(3 days)
high activity
foraging↑
high FC
reproduction ↓

Discussion

- Why FC gets higher in later season ?
- energetic loss and egg quality,time of the season ···

Why only low-activity group changed?
reaction norm plasticity-personality correlation

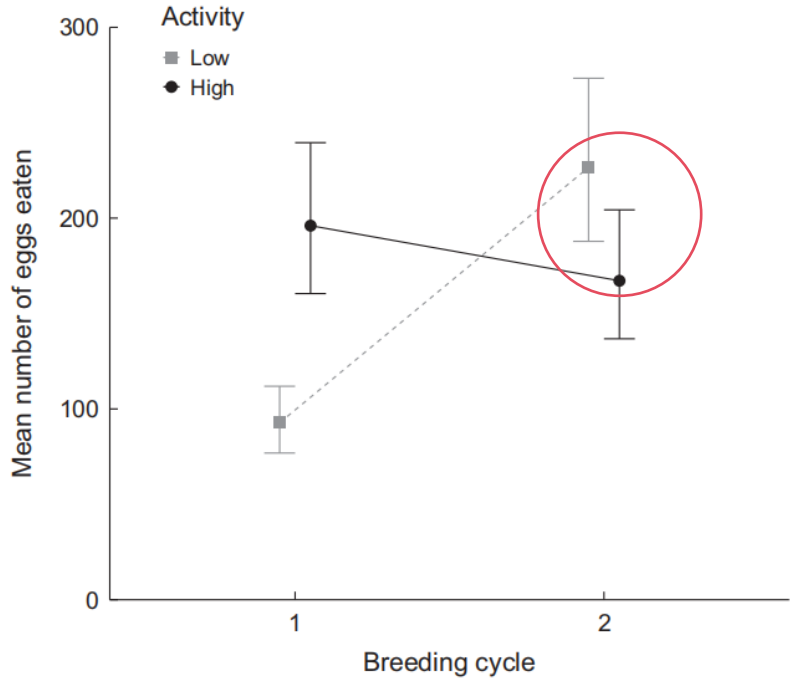


Figure 6. Interaction plot based on model estimates for the mean absolute number of eggs cannibalized per fish (excluding cases of TFC). Presented are group means and standard errors for each factor combination of activity and breeding cycle.

Question

- Whether the daily food ration is sufficient has not been verified under all conditions.Data on leftover food is not available.So energy-loss based explanation can’t be ruled out completely.
- Initially,this study focus on personality,the consistency of individual behaviors over time and across contexts.But when convergence happened in breed cycle 2,they said degree of individual plasticity varied among individuals and correlated with the underlying personality trait.Can they really be put together?
- In experiment 2，As male activity wasnot measured again after the initial activity scoring, there are no data to further assess what caused the two groups to converge in brood cycle 2.