Does phenotypic plasticity undermine the reliability of sexual advertisement or help sustain adaptive mate choice?

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Does condition-dependence help maintain genetic variation?

Sexually-selected ornaments and displays often exhibit **condition-dependent phenotypic plasticity**: trait expression depends upon how well an individual can acquire resources from its environment.

Condition-dependence means that the 'best' male genotype may change if the local environment is variable: plasticity should help maintain additive genetic variation under the directional selection imposed by female mate choice. However…

Could plasticity degrade the value of the male signal?

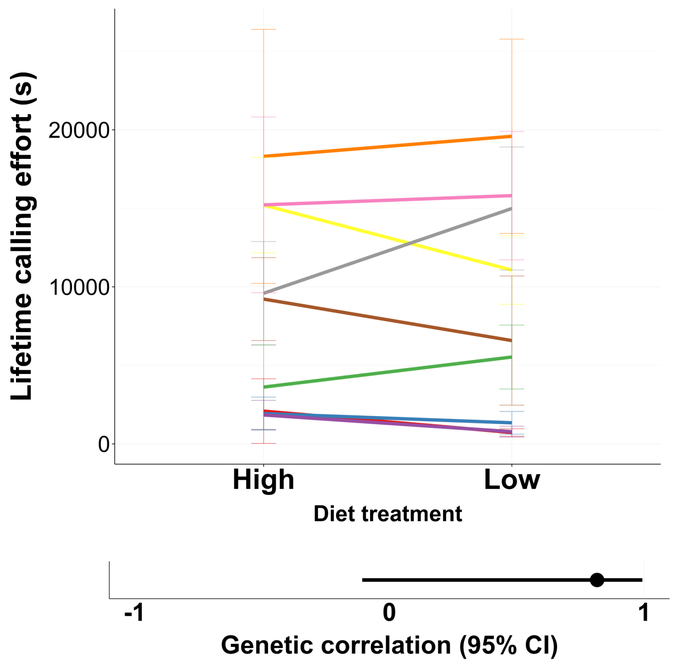
Female choice for indirect genetic benefits requires that the male signal is a reliable indicator of some aspect of his **genetic quality**. If male quality is highly unpredictable across heterogeneous environments, this would compromise the expected benefits of female mate choice.

Assessing a male sexual signal in different environments

We used a diet treatment (high- and low-nutrient diets) in 9 inbred genetic lines of the decorated cricket *Gryllodes sigillatus* (top) to manipulate condition among males of distinct genotypes, and measured the sexually-selected trait in each male.

Male crickets attract females by creating an acoustic signal via stridulation; female crickets prefer males that call more. We recorded male 'calling effort' (the number of seconds spent calling overnight) on a weekly basis from 7 days after reaching adulthood until death. A male's lifetime calling effort is the total of all measurements made during his life.

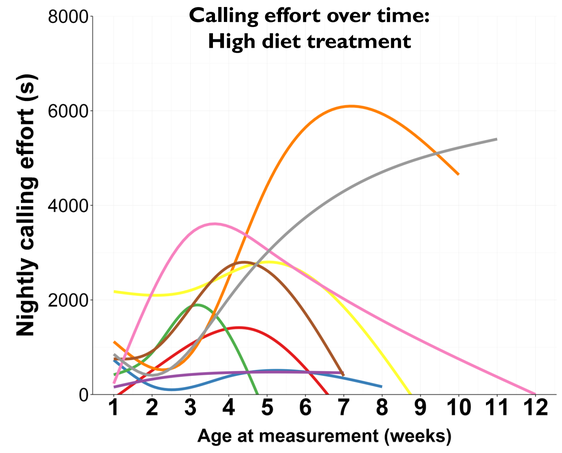
Phenotypic plasticity is shown using reaction norms (below): a change in the means across environments shows whether the trait is sensitive to environmental effects. The lines represent the reaction norms (±1 s.e.) for each of our different genotypes.



Despite differing lifespans between males, we found that the genetic correlation for total calling effort across environments is large and positive (above). Total calling could be considered a reliable signal: the genetic correlation indicates that male genotypes that call more in one environment also tend to call more in the other.

However, females inspect males at timepoints, and relative to other males. For nightly calling effort to be reliable, the pattern of calling over time should also be predictable within environments.

Age-related change in male calling effort

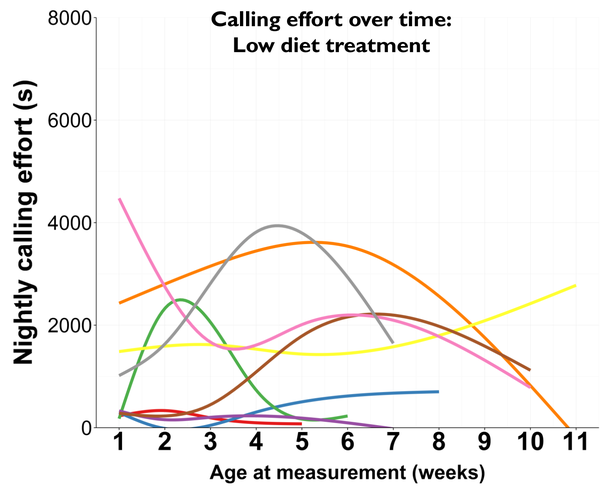


A male's total calling effort is a function of his lifespan and his trajectory of age-related investment.

An individual's condition is liable to change with age. When individuals express traits repeatedly over their lifetimes, current condition will mediate investment in current and future signalling. Age-related changes in condition should thus affect the pattern of calling effort over male lifespan.

Smoothed representations of male nightly calling effort over time for each genotype in high- (above) and low-nutrient (right) diets indicate effects of diet, age and genotype on the trajectory of calling (Table 1).

Age-dependent changes in condition can, therefore, obscure the relationship between genotype and phenotype even within the local environment.



	Estimate	95% CI	pMCMC
Diet	1.04	(0.38, 1.79)	0.006
Age	0.06	(0.03,0.10)	<0.001
Age^2	-0.0007	(-0.001, -0.0008)	0.054
Diet × Age	-0.006	(-0.1, -0.007)	0.014
Diet × Age^2	0.0007	(-0.0002, 0.002)	0.100

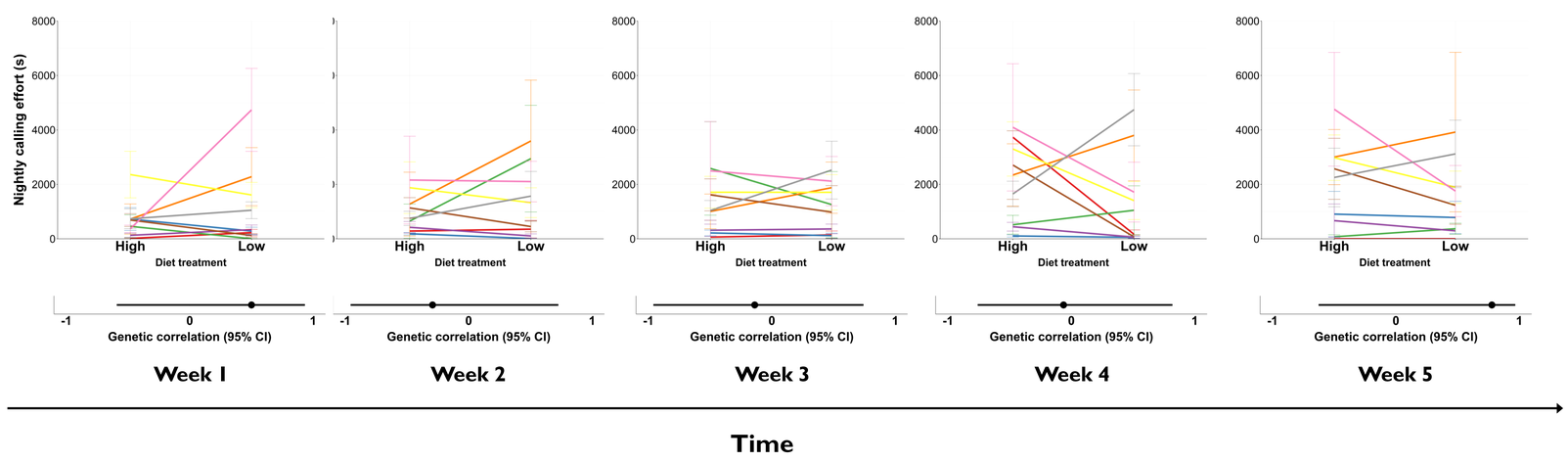
Table 1: parameter estimates from MCMCglmm analysis of diet- and age-related change in nightly calling effort after conditioning upon genotype.

Cross-environment genetic correlations vary with age

While the genetic correlation for total calling effort is strongly positive across environments, the patterns of weekly measurements over time and across diets are far more variable.

Genetic correlations across environments change with age (right), meaning that the value of choice may depend largely upon the timing of choice itself.

Given that the sign of the correlation changes between weeks, if female preferences act consistently then male calling effort would be highly unreliable as a signal of male quality across environments.



Behavioural signals are often complex, plastic, polygenic, and expressed repeatedly over a male's lifetime. These factors fuel extensive genetic variation, which female choice is unlikely to deplete. However, genetic differences in allocation trajectories both within and across environments surely cause a problem for signal reliability. How does preference evolve and persist under such conditions? Studies of the relative costs and benefits of preference to females, and of the genetic differences in the trajectories of sexual signalling, are required to provide further insights into this topic.

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