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PLASTICITY OF OFFSPRING GROWTH RATE IN WILD-DERIVED MICE IS PREDICTED BY PARENTAL SOCIAL FACTORS

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The ability of parents to influence offspring traits is an important source of adaptive phenotypic plasticity in mammals. By contrast, parental effects failing to regulate offspring phenotype to fit current environmental conditions could be deleterious. Although parental responses to single cues have been identified, we lack an understanding of how these factors interact and whether they are reversible across breeding cycles in a fluctuating environment. Social status in wild house mice periodically fluctuates, changing the high-fitness pathways available to offspring. We designed an experiment to parse how parental factors interact and subsequently whether they are reversible.

We monitored wild-derived mice populating semi-natural enclosures for 11 weeks and simultaneously a non-competition, control group. In the enclosures, we identified dominant males with exclusive occupancy of optimal territories – defendable food and nesting resources – and non-dominant males without said territoriality. Afterward, we paired mice monogamously for 10 days, according to a reciprocal breeding design. A subset of competition males, entered a second round of competition against other males of their previous social status. This winners-losers bracket design forced some males to gain or lose dominance, while other males maintained dominance or non-dominance. In total, these pairings produced over 900 offspring from 129 litters, each with various combinations of parental social experiences, litter sizes, and sex ratios. After weighing these offspring weekly, we systematically assessed which parental factors influence offspring growth and how these factors interacted. Offspring growth was analyzed with separate pre- and post-puberty linear mixed models (LMMs), because mice grow at two different, but near linear rates. The best-fit LMMs—selected by lowest Akaike Information Criterion—were structurally identical and included the fixed-factors: age, sex, litter size, litter sex ratio, maternal social experience, paternal social status, and all of their interactions. Both models also required including random-factors to control for sibling-level relatedness and repeated measures of the same individual.

We found for wild-derived house mice, recently dominant males produced faster growing pre-pubescent offspring; however, subsequent offspring of those same males would grow relatively slower if-and-when dominance was lost, and vice versa. This supports status related cues, not genetic associations, as the underlying basis for the plasticity of offspring growth rates. Furthermore, these paternal-status associated body-size effects persisted beyond puberty, which would likely influence life-long reproductive success. Maternal experience modulates the timing, effect-size, and sex-specificity of this paternal effect, in part by interacting with litter size and sex ratio. Most notably, mothers with competitive experience appeared better at identifying the most recent social status of new mates—males they've never smelled or seen before. Specifically, competition females exhibited stronger positive growth effects on dominant-sired offspring—especially sons—compared to inexperienced mothers, while significantly slowing the growth of offspring sired by non-dominant males. Strikingly, pairing with a non-dominant male

also positively predicted infanticide rates, which indirectly increased the growth rates of the surviving offspring. Taken together, we have shown the importance of considering parental social experience and their subsequent interactions to better explain variation in mouse offspring growth. Furthermore, reversible phenotypic plasticity across breeding cycles is an important and previously unappreciated possible feature of parental effects in mammals.