

Cooperative breeding and hominin brain size evolution

Evidence from a comparative study in birds



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In mammals, allomaternal energy inputs correlate with either large brains or increased reproductive rates¹. In this study we investigated the effects of allomaternal care on brain size and life history in birds. First, we showed that energetic input during breeding correlates with relative brain size. Second, we found that helpers in birds do not increase brain size or reproduction but rather increase the survival rates of parents. These findings in birds enhance our understanding of how cooperative breeding may have shaped hominin evolution.



Introduction. Humans are characterized by huge brains and high reproductive rates in comparison to great apes, which we aim to explain using a comparative phylogenetic approach. In mammals, the amount of energy subsidies during breeding has been found to correlate positively with either relative brain size (in carnivores and rodents, and in mammals as a group), or with reproductive rate (in nonhuman primates)¹. Thus, allomaternal help alleviates the trade-off between energy used for reproduction and for brain growth and maintenance^{2,3}. Here, we investigate the effects of allomaternal care in a wide range of bird species.

Material & Methods. Data on brain and body mass, life history traits, breeding behavior, and field metabolic rates during breeding and non-breeding periods were taken from the literature (N > 600 bird species). We quantified the amount of allomaternal care as 1) the total energy input during breeding and 2) the number of caretakers. Analyses were conducted with phylogenetic least squares regressions in R (PGLS, package caper).

Energetic input during breeding and brain size. Total energetic input during breeding is positively correlated with relative brain size (PGLS: N=59, p=0.0006 (+), controlled for body mass and development mode) (fig. 1). However, our dataset of breeding metabolic rates contains only a small number of single-breeder species, which precludes any conclusions about the effects of helpers on this total energetic input.

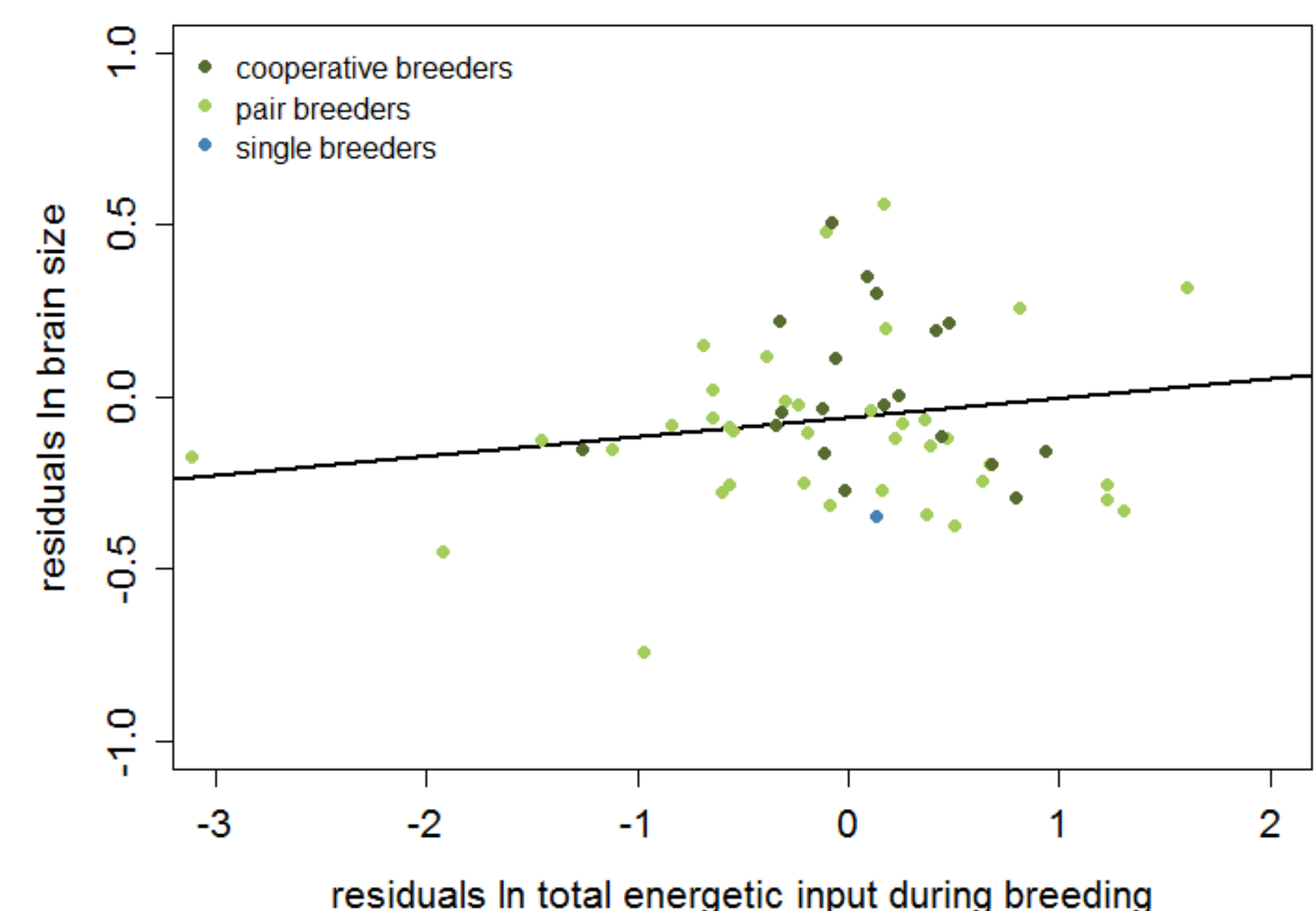


Figure 1. Brain size vs. total energetic input during breeding.

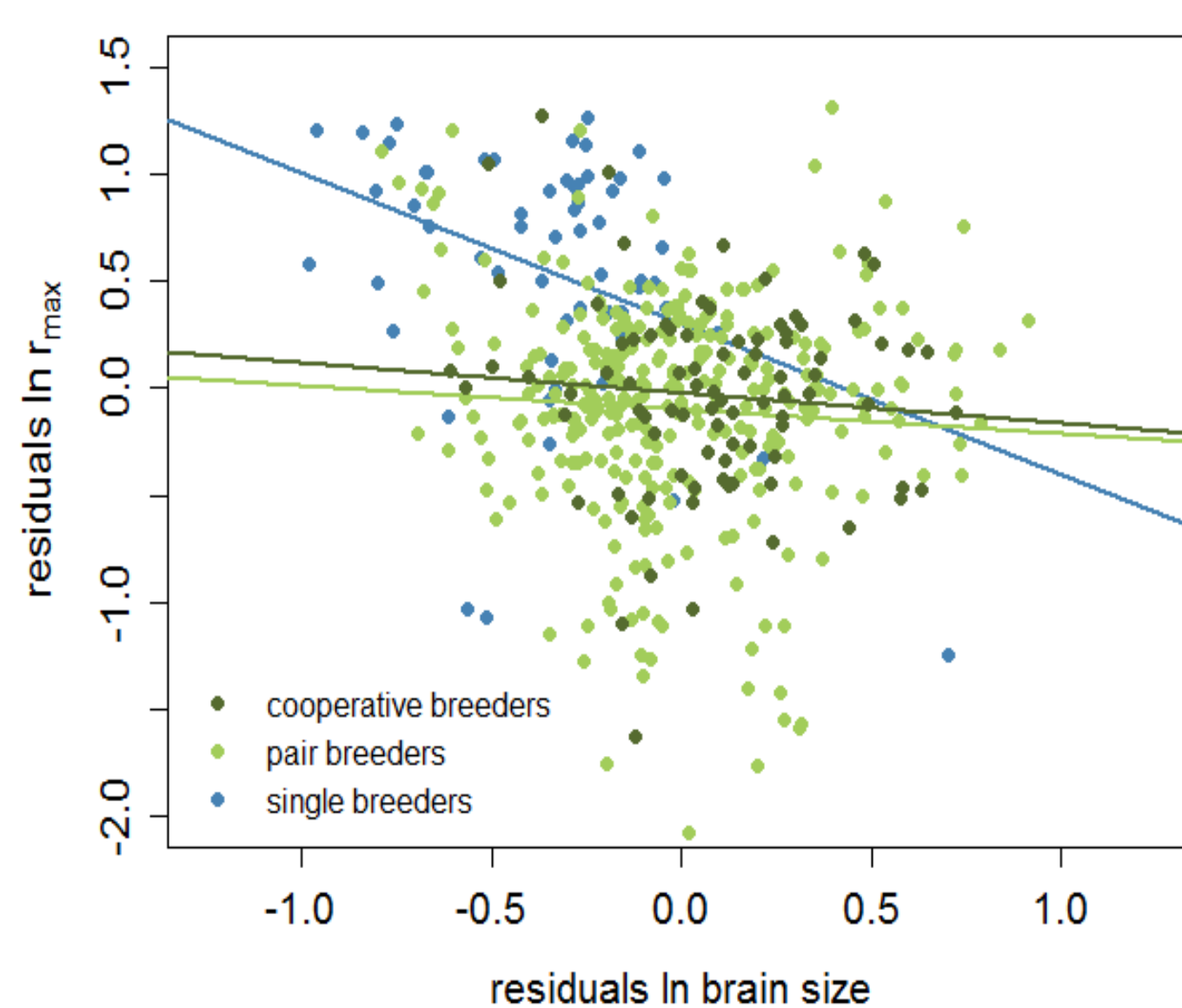


Figure 2. Reproductive rate (r_{max}) vs. relative brain size shown separately for different breeding types. PGLS: single breeders: N=58, p=0.07 (-), pair breeders: N=295, p=0.48 (-), coop. breeders: N=86, p=0.73 (-)

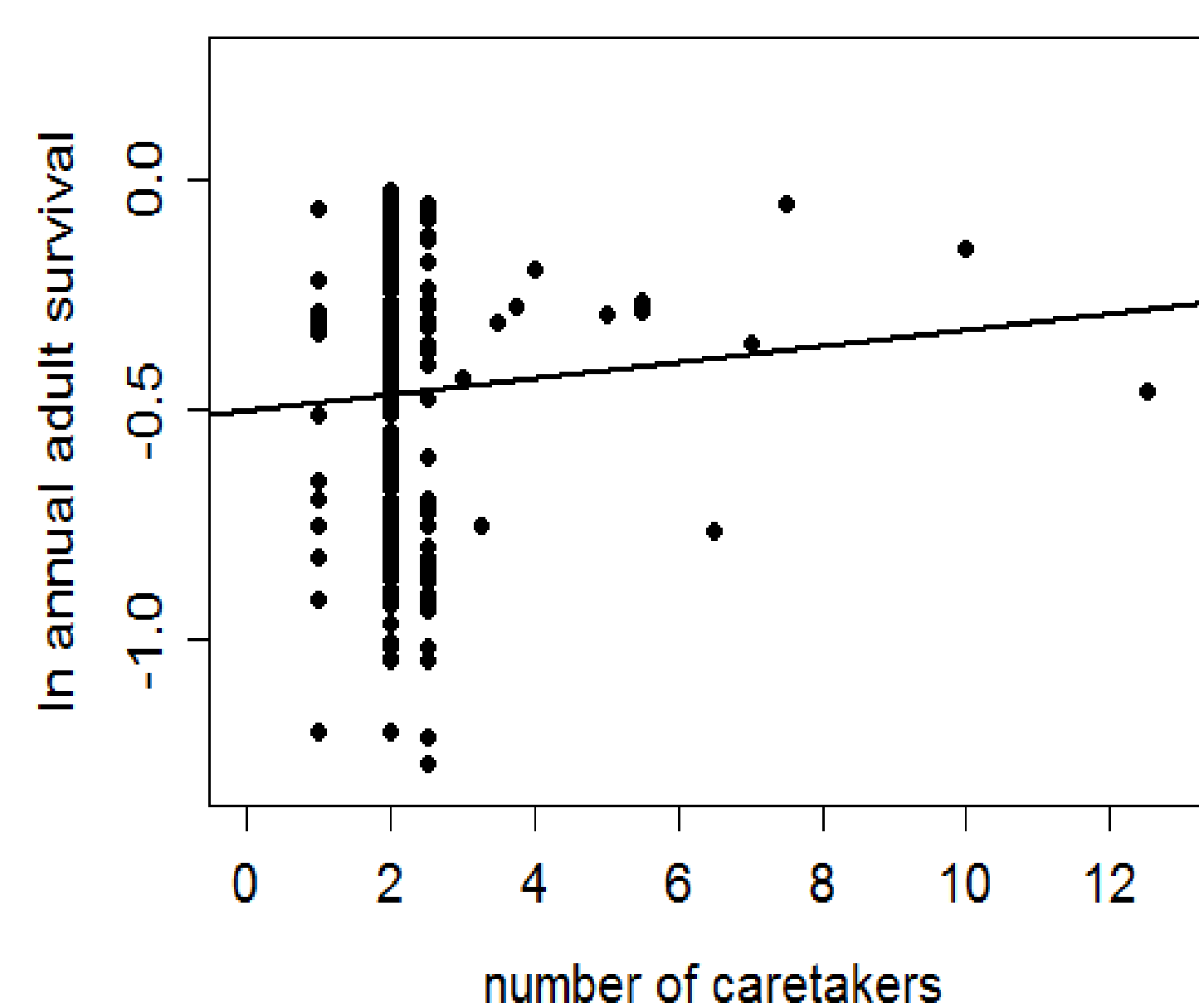


Figure 3. Annual adult survival vs. number of caretakers during breeding.

Effects of helpers. As in mammals, bird species without allomaternal care show a negative correlation between reproductive rate and relative brain size, whereas this trade-off is alleviated in pair or cooperatively breeding species (fig. 2).

The number of helpers does not affect relative brain size (PGLS: N=1413, p=0.78 (+)) or reproductive rate (PGLS: N=421, p=0.78 (+)), but it increases adult survival rates (fig. 3) (PGLS: N=268, p=0.02 (+)) (all controlled for body mass and development mode). Thus, the load-lightening of mothers allows cooperatively breeding species to evade the trade-off between reproductive rate and relative brain size.

Conclusions. In contrast to mammals, neither brain size nor reproductive rate are positively affected by additional help during breeding, but the presence of helpers increases adult survival. In sum, our results provide additional evidence for the cooperative breeding hypothesis⁴, which postulates that a change towards allomaternal child care stood at the beginning of the ever-increasing brain size of the human lineage. Independently of an effect on brain size or reproductive rate, allomaternal care could also have had a direct effect on female survival and thus on longevity.

References

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Acknowledgements

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