Ecological vs. Social Complexity
Drivers and Consequences of Enlarged Brains in Primates

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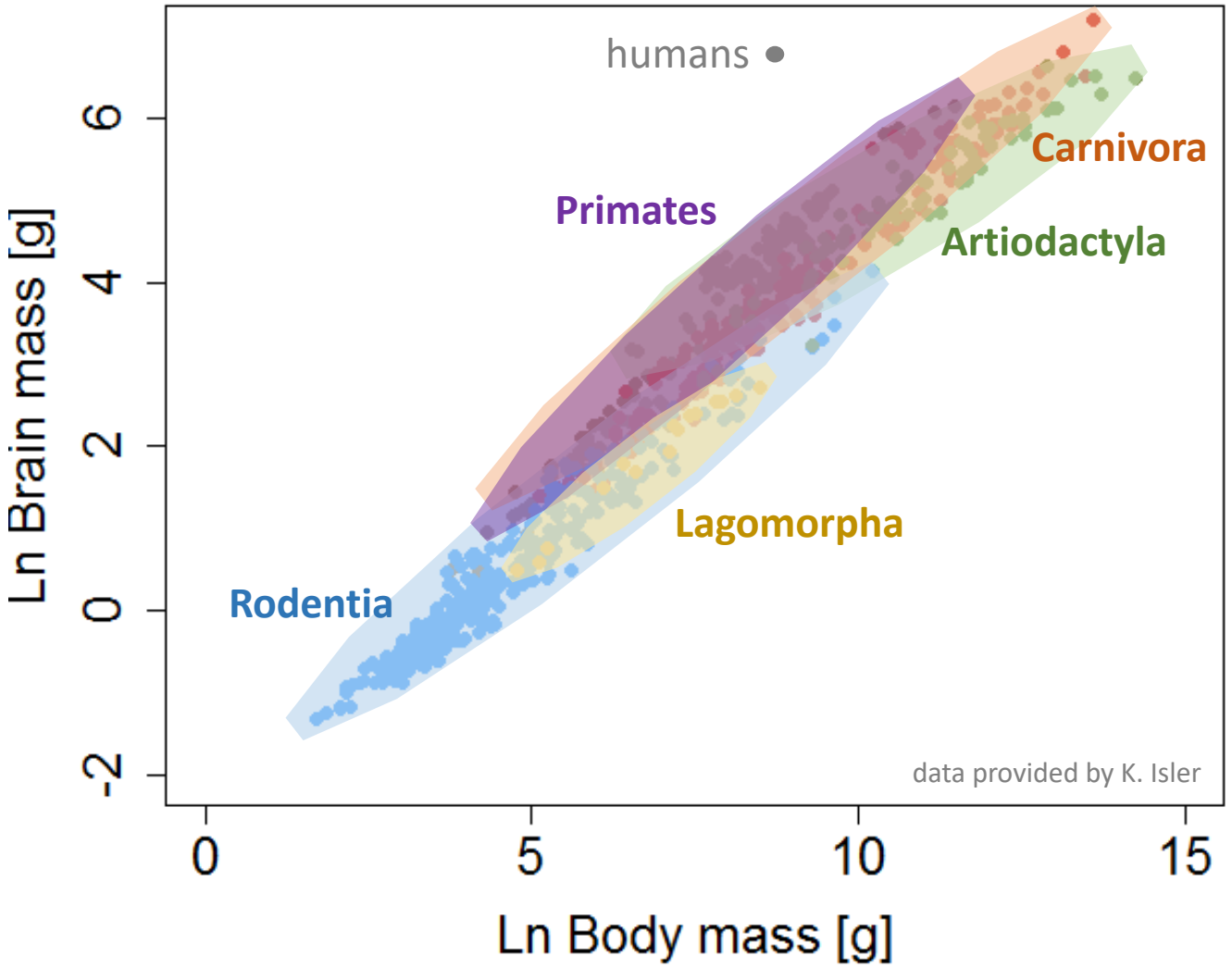
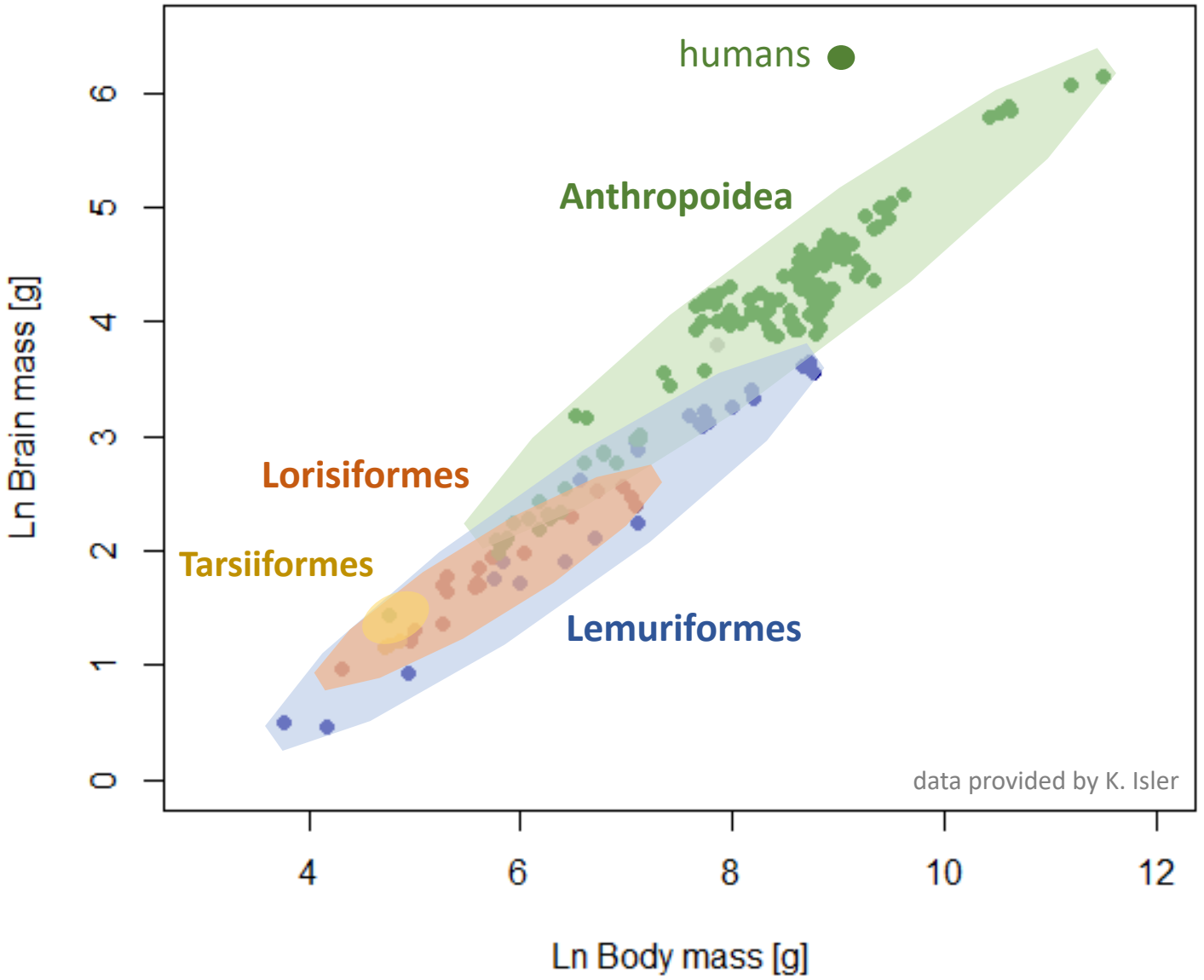
Variation in Brain Size - Mammals

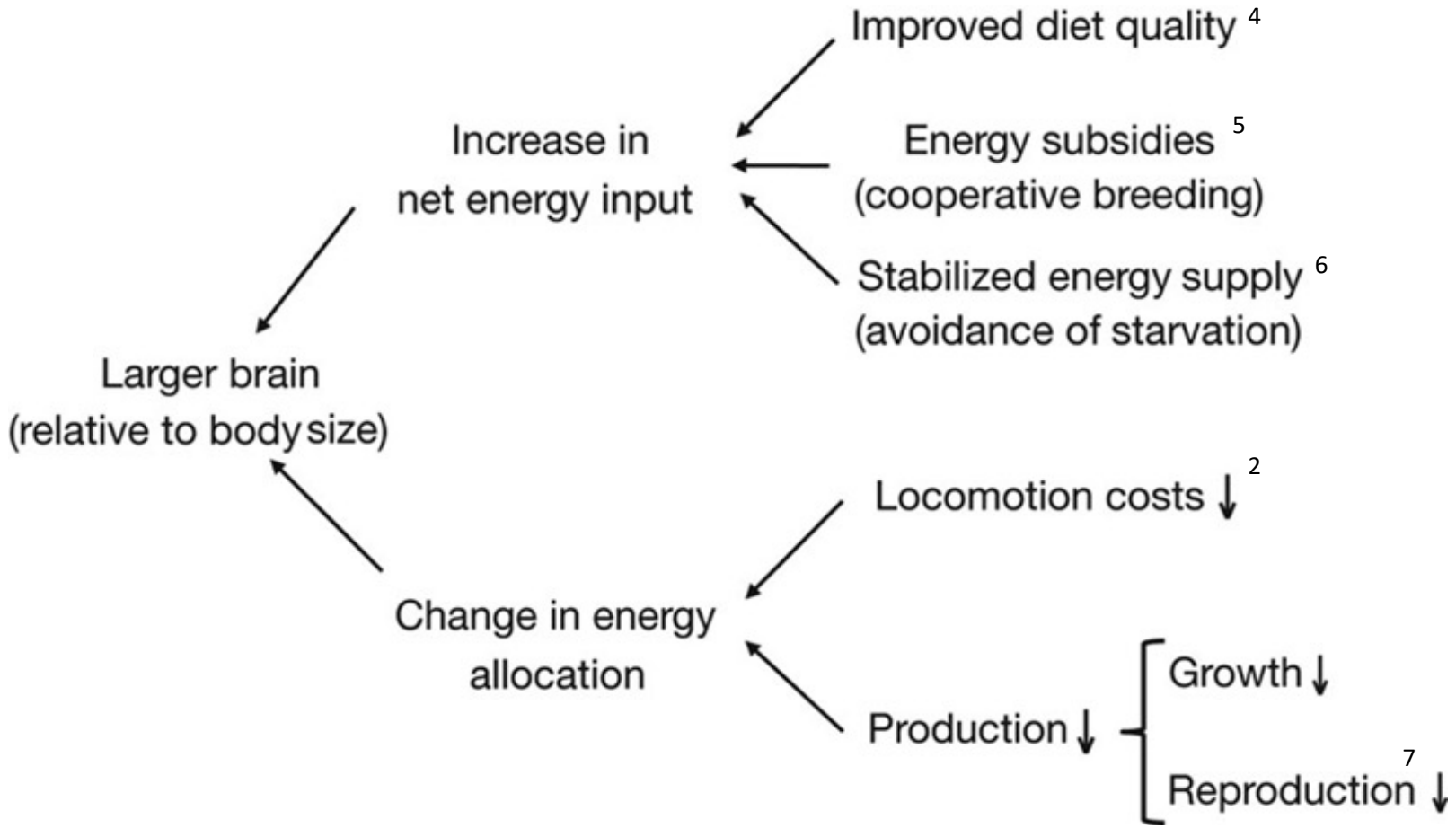


Variation in Brain Size - Primates



Explaining Variation in Brain Size

Cost perspective – Expensive brain framework[1, 2, 3]



[1]Isler & van Schaik 2009a; [2]Navarrete et al. 2011; [3]Isler & van Schaik 2009b, [4] e.g. Isler and van Schaik 2006; [5] Isler and van Schaik 2012; [6]van Woerden et al. 2010, 2011, 2014; [7]e.g. Isler & van Schaik 2009

Explaining Variation in Brain Size

Cost perspective – Expensive brain framework[1, 2, 3]

Keep in mind costs and constraints!

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Explaining Variation in Brain Size

Benefit perspective – Sociality and Ecology

Selective agent	Hypothesis
Social benefits	**Social Brain** (Byrne and Whiten 1988; Dunbar 1998) Social complexity.
Ecological benefits	**Technical intelligence** (Parker and Gibson 1977; Gibson 1990; Byrne 1997) Extractive foraging, tool use.
	Cognitive mapping (Milton 1988; Gibson 1986) Spatio-temporal orientation.
	Cognitive buffer (Allman et al. 1993; Sol et al. 2008) Environmental fluctuations.

Shortcomings of previous studies

- Tested only one or the other domain
- Simple ad-hoc measurements

Explaining Variation in Brain Size

Benefit perspective – Sociality and Ecology

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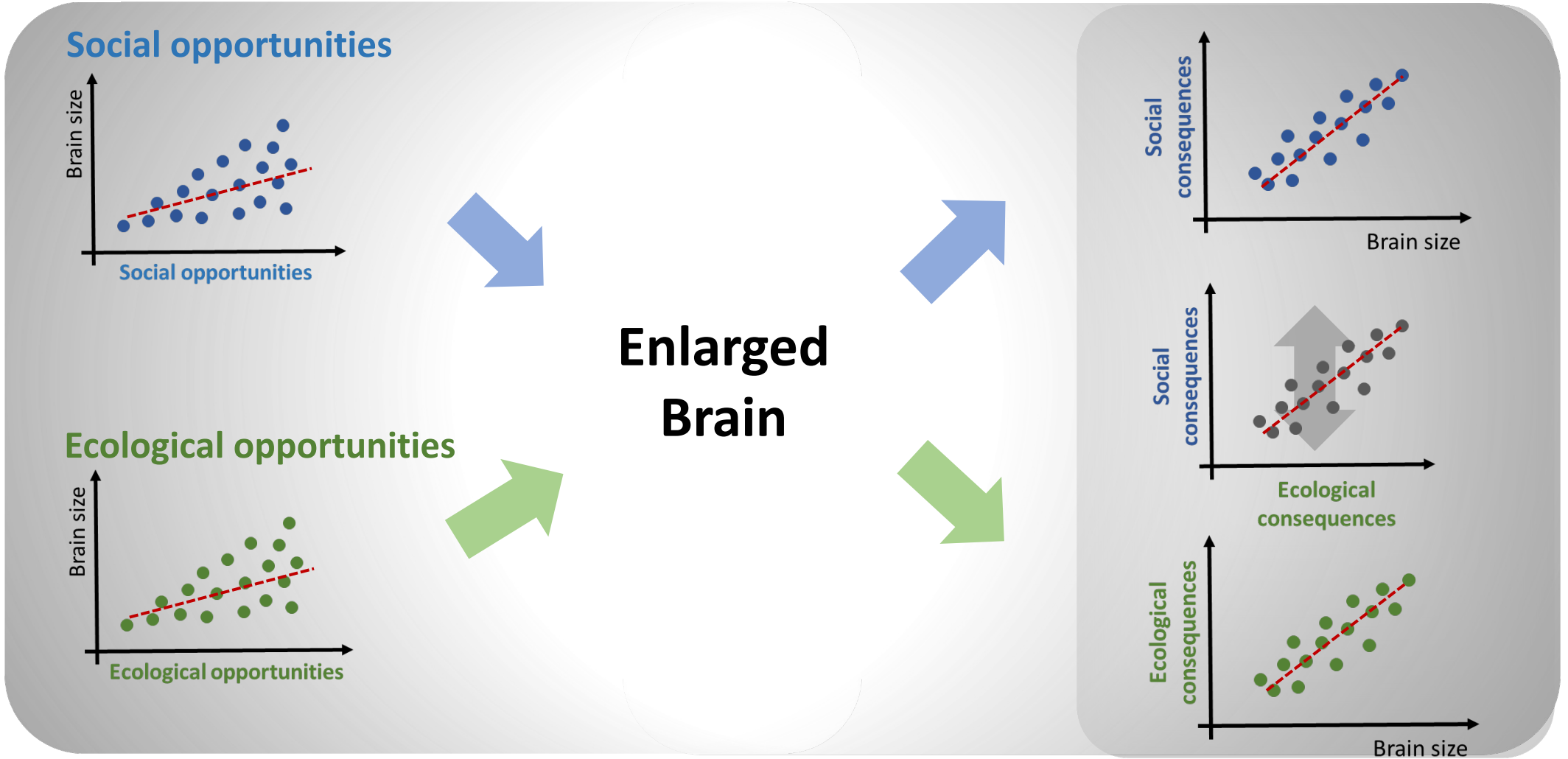
New approach

- Include a broad range of social and ecological variables
- Systematic distinction between possible selective pressures and cognitive consequences of enlarged brains

Explaining Variation in Brain Size

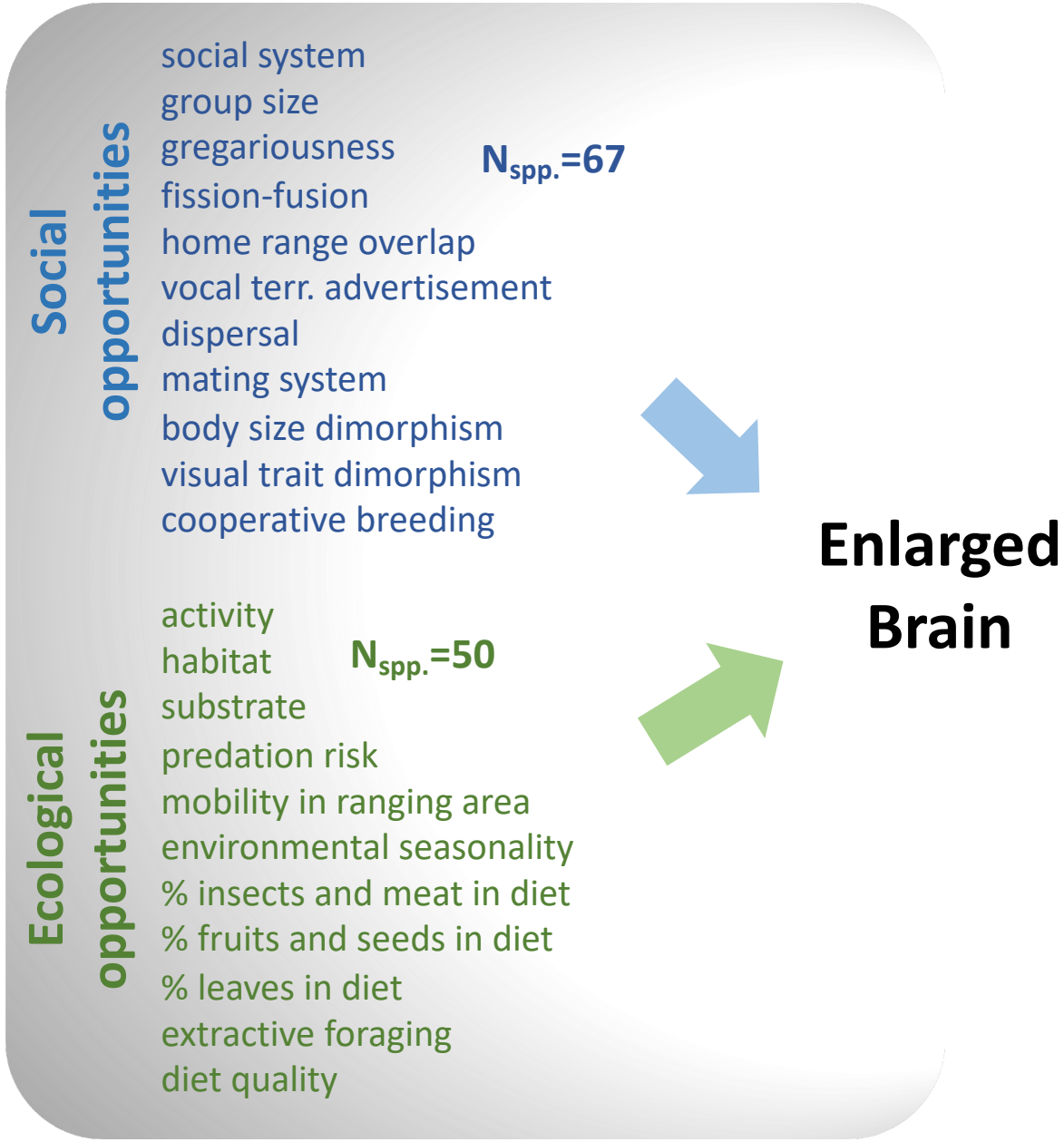
Concept of opportunities and consequences



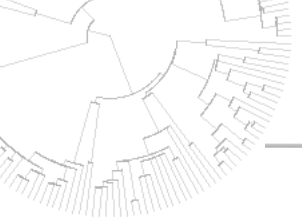
Facilitation of enlarged brains

Direct effects of enlarged brains

Opportunities and Consequence Variables



Opportunities and Consequence Variables



Social opportunities $N_{spp.}=67$

social system
group size
gregariousness
fission-fusion
home range overlap
vocal terr. advertisement
dispersal
mating system
body size dimorphism
visual trait dimorphism
cooperative breeding

Ecological opportunities $N_{spp.}=50$

activity
habitat
substrate
predation risk
mobility in ranging area
environmental seasonality
% insects and meat in diet
% fruits and seeds in diet
% leaves in diet
extractive foraging
diet quality

Enlarged Brain

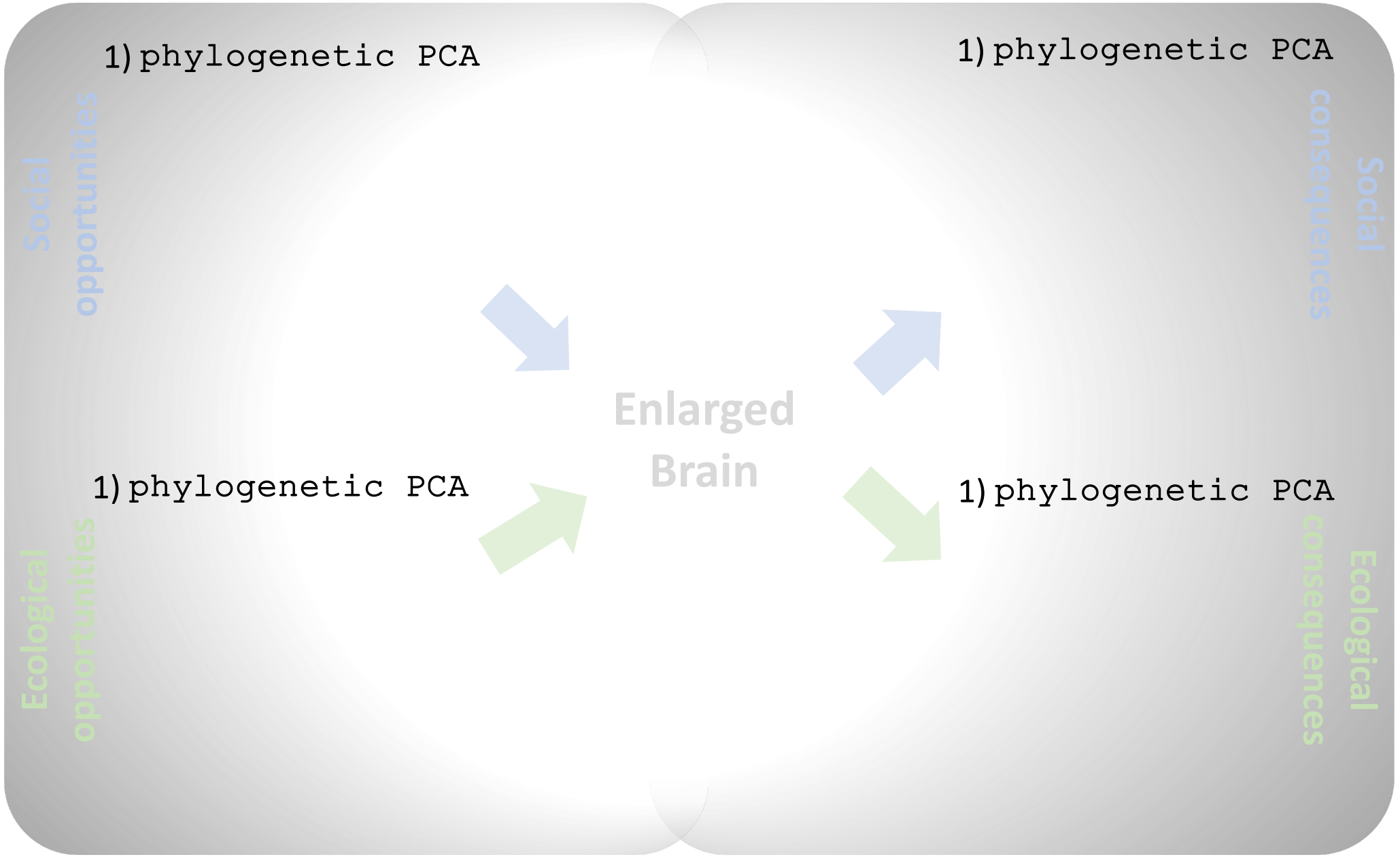
Social consequences $N_{spp.}=60$

social learning frequency
coalition formation
social hunting
food sharing among adults

Ecological consequences $N_{spp.}=53$

buffering env. seasonality
diet breadth
hunting
tool use

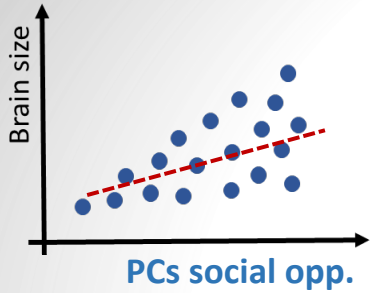
Phylogenetic Analyses



Phylogenetic Analyses

1) phylogenetic PCA

2) PGLS regression



Enlarged Brain

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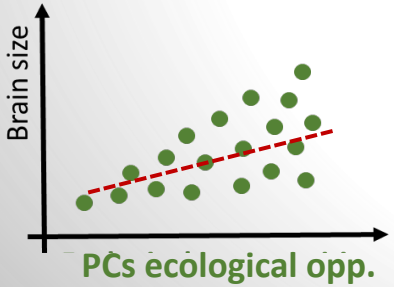

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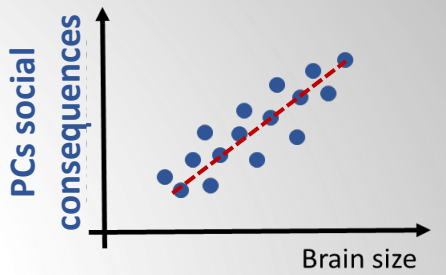

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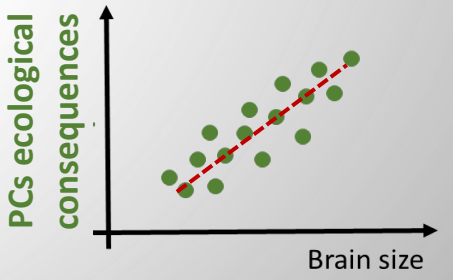
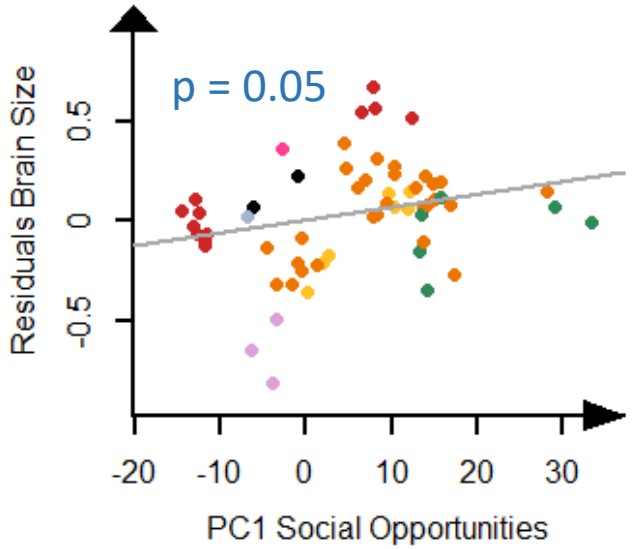
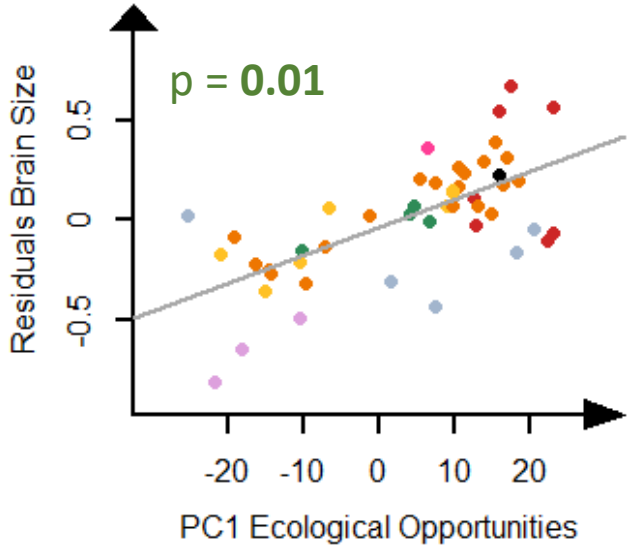


Ecological more than social opportunities allow for enlarged brains





Enlarged Brain

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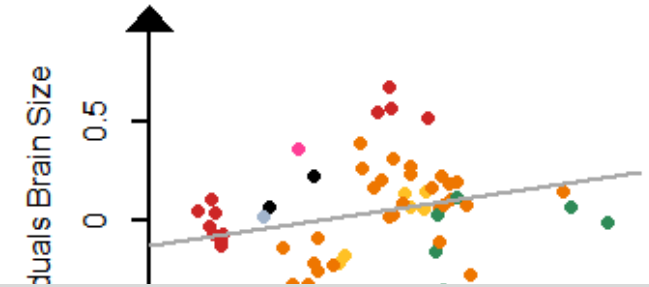
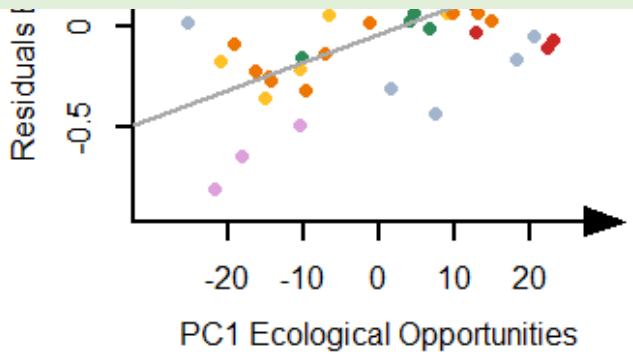
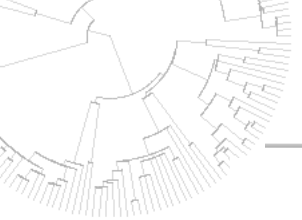


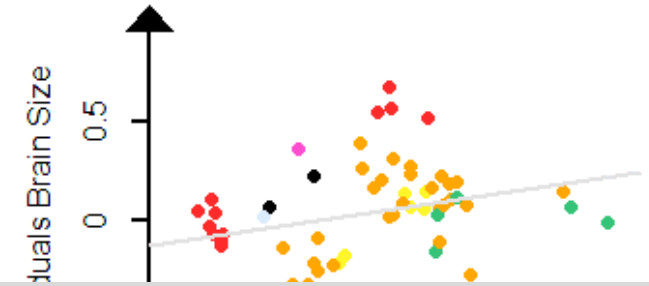
	p-value
PC1 Social opportunities	0.44
PC2 Social opportunities	0.70
PC1 Ecological opportunities	**0.02**
PC2 Ecological opportunities	*0.09*



Enlarged Brain

Enlarged brain allows for complex social and ecological cognitive abilities





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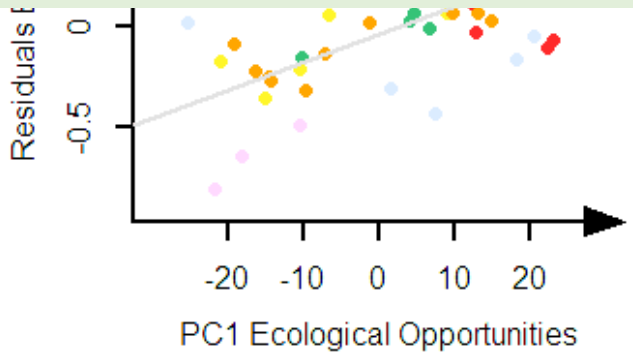
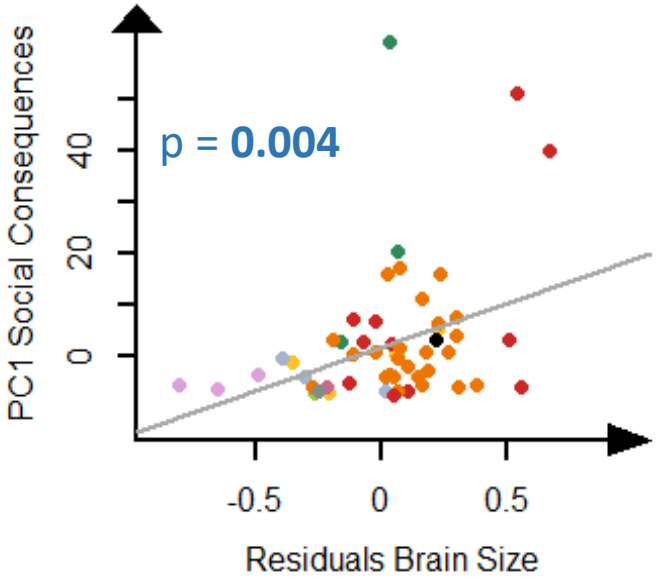
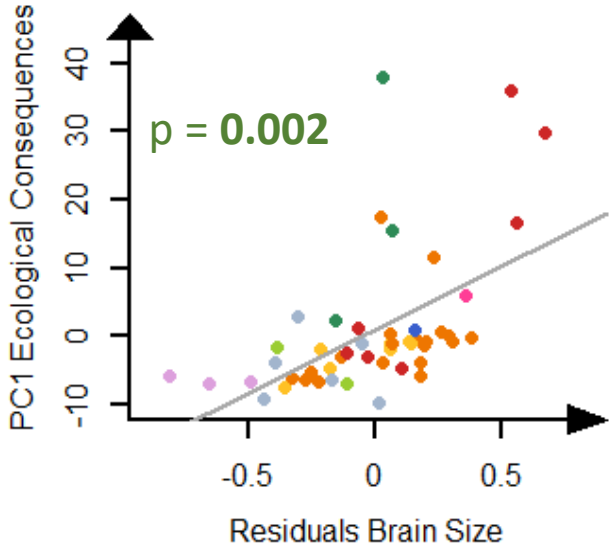


Enlarged Brain

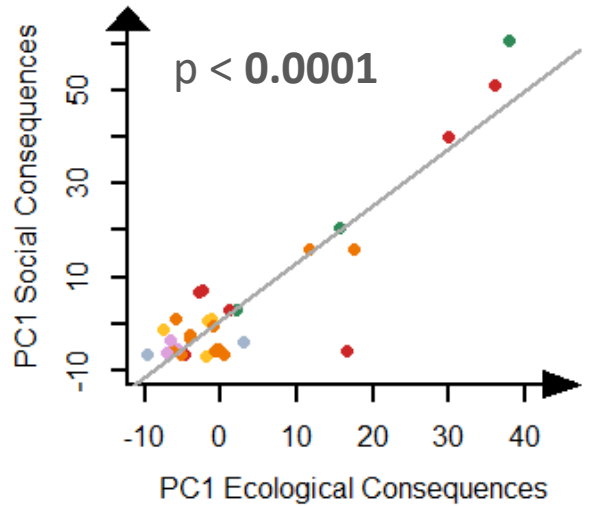




Social & ecological consequences are highly interrelated

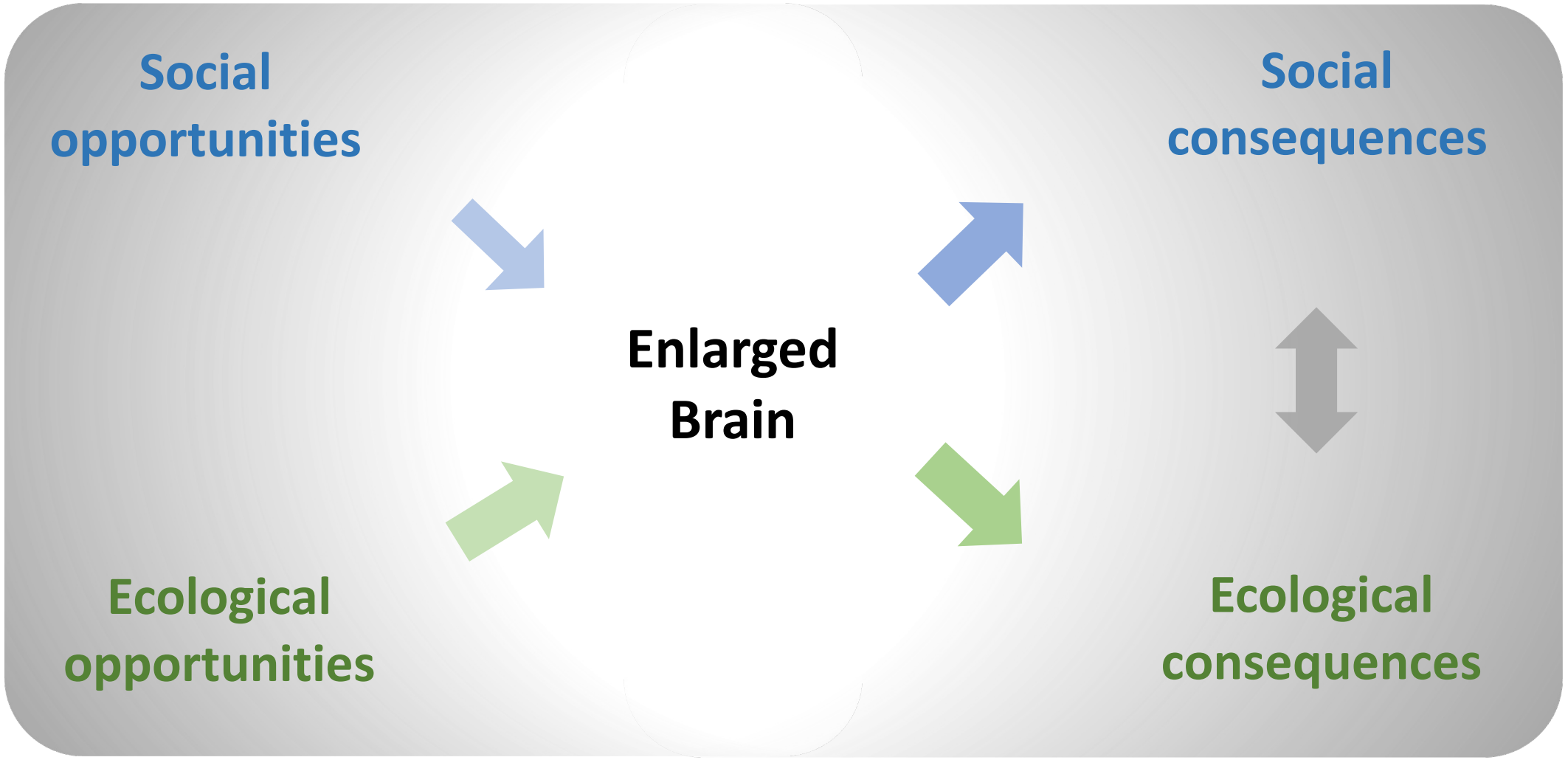
Enlarged Brain

Social consequences



Ecological consequences

Socioecology and Brain Size - Conclusions



Ecological preconditions allow for the evolution of complex cognition

Thank you…

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- Erik Willems

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Universität Zürich[UZH]

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