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EDITORIAL
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Editorial: Cognition and Adaptation to Urban Environments

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Editorial on the Research Topic

Cognition and Adaptation to Urban Environments

Urbanization frequently causes discrepancies between organism phenotypes and their environment (Johnson and Munshi-South, 2017; Diamond and Martin, 2021; Lambert et al., 2021). Although selection may help some species adapt to urban environments, the changes to the environment associated with urbanization can be so rapid and drastic that evolution may not allow the timely establishment of a new phenotype-environment match (Szulkin et al., 2020). One potential solution is cognition, which regulates how animals collect, store and use information about their environment (Shettleworth, 2001). By allowing organisms to learn responses to novel challenges, and to select resources and micro-habitats that better match their phenotypes, cognitive processes may be an important tool that organisms can use to adaptively respond to urbanization (Sol et al., 2020).

However, whether and how variation in cognition alters species or individual responses to urbanization remains an open question (Griffin et al., 2017; Sol et al., 2020). Urban populations may express cognitive traits that differ from their rural counterparts if for example these traits favor their success in cities. Urban areas may also filter species or individuals based on their cognitive abilities so that those with the ability to flexibly respond to urban conditions may be favored. Importantly, cognitive processes can also potentially affect evolutionary responses by facilitating or hindering adaptive evolution in urban environments (Sol et al., 2020). For example, some cognitive traits may reduce the risk of population extinction (Ducatez et al., 2020), allowing natural selection to move the population closer to a new adaptive peak (Ducatez et al., 2020). Alternatively, by favoring plastic responses to environmental changes, cognition may allow populations to mitigate natural selection, weakening the strength of selection on morphological or physiological traits. Cognition may thus play an essential role in adaptation to urban environments, though empirical evidence testing these mechanisms is still lacking.

This Research Topic aims to bring together different pieces of research investigating the relationship between urbanization and cognition. Two meta-analyses and a review article provide an overview of the state of the art, while two research papers report case studies in mammals. Vincze and Kovács show that urban animals tend to outperform non-urban conspecifics in their problem-solving capacities. However, their meta-analysis reveals the limited number of existing studies (12 in total) and the strong taxonomic bias toward birds (3/4 of the studies), making any generalization speculative at this stage. To move this field of study forward, they underline the need for investigations in taxa other than birds. Gomes et al. focused on studies of animal acoustic behaviors in a meta-analysis of research comparing

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urban and non-urban animals. Although they detected consistent differences in acoustic parameters in birds (including song frequency, duration, and amplitude), only call amplitude showed a significant difference in anurans, while no acoustic differences were detected between urban and non-urban insects. In these two taxonomic groups, however, fewer studies were conducted and far fewer parameters were measured as compared to birds.

Birds, therefore, have been a model group to investigate the impact of urbanization on animal cognition, as already acknowledged elsewhere (Griffin et al., 2017; Sol et al., 2020). As a result, Lee and Thornton also primarily relied on results from bird studies to develop their review paper where they discuss the existing evidence for differences between urban and non-urban populations, and attempt to identify the drivers or mechanisms responsible for these differences. Filtering effects and natural selection are likely to contribute to the variation observed. Their review underscores that future studies should aim to distinguish the importance of these mechanisms in generating the cognitive differences that are sometimes detected between urban and non-urban populations.

This Research Topic also contains two case studies focused on mammals. Mazza et al. compared the neophobia of two small rodents, and did not detect any clear behavioral difference related to urbanization. Similarly, Chow et al. found few differences between urban and non-urban gray squirrel populations when comparing their performances at four cognitive tasks measuring problem-solving, motor memory and spatial learning. In addition to urban and rural populations, they also compared invasive and native populations, which added a level of complexity, providing an opportunity to discuss the importance of cognition in two different yet similar contexts that have surprisingly been rarely considered together (but see Cadotte et al., 2017; Sol et al., 2017; González-Lagos et al., 2021): the successful introduction to, or invasion of, a new geographic area and the successful adaptation to, or colonization of, urban areas. Their study also emphasizes the need to conduct cognitive tests in nature instead of in captivity, avoiding some of the biases most studies are exposed to (especially variation in habituation and stress responses to captivity).

Together, this body of research provides an update on the current state of research on cognition in the context of urbanization and highlights the need for more research on this Research Topic, especially in taxa other than birds. Behavioral and cognitive traits appear to vary with urbanization in some species, but we still lack sufficient data to draw general patterns of variation across taxa. A critical future direction will be to investigate the mechanisms responsible for differences in cognition between urban and non-urban populations. Is cognition evolving in response to urbanization? Or do urban environments filter individuals based on their cognitive abilities? We hope that this Research Topic will spur future research in that direction, and thank the authors for their excellent contributions.

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SD wrote a first draft which was then reviewed and commented by JD, MW, and J-NA. All authors validated the final version. All authors contributed to the article and approved the submitted version.

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REFERENCES

Cadotte, M. W., Yasui, S. L. E., Livingstone, S., and MacIvor, J. S. (2017). Are urban systems beneficial, detrimental, or indifferent for biological invasion? *Biol. Invasions* 19, 3489–3503. doi: 10.1007/s10530-017-1586-y

Diamond, S. E., and Martin, R. A. (2021). Evolution in cities. *Ann. Rev. Ecol. Evol. Syst.* 52, 519–540. doi: 10.1146/annurev-ecolsys-012021-021402

Ducatez, S., Sol, D., Sayol, F., and Lefebvre, L. (2020). Behavioural plasticity reduces extinction risk in birds. *Nat. Ecol. Evol.* 4, 788–793. doi: 10.1038/s41559-020-1168-8

González-Lagos, C., Cardador, L., and Sol, D. (2021). Invasion success and tolerance to urbanization in birds. *Ecography* 44, 1642–1652. doi: 10.1111/ecog.05826

Griffin, A. S., Netto, K., and Peneaux, C. (2017). Neophilia, innovation and learning in an urbanized world: a critical evaluation of mixed findings. *Curr. Opin. Behav. Sci.* 16, 15–22. doi: 10.1016/j.cobeha.2017.01.004

Johnson, M. T. J., and Munshi-South, J. (2017). Evolution of life in urban environments. *J. Evol. Biol.* 358:eaam8327. doi: 10.1126/science.aam8327

Lambert, M. R., Brans, K. I., Roches, S. D., Donihue, C. M., and Diamond, S. E. (2021). Adaptive evolution in cities: progress and misconceptions. *Trends Eco. Evol.* 36, 239–257. doi: 10.1016/j.tree.2020.11.002

Shettleworth, S. J. (2001). Animal cognition and animal behaviour. *Anim. Behav.* 61, 277–286. doi: 10.1006/anbe.2000.1606

Sol, D., Bartomeus, I., González-Lagos, C., and Pavoine, S. (2017). Urbanisation and the loss of phylogenetic diversity in birds. *Ecol. Lett.* 20, 721–729. doi: 10.1111/ele.12769

Sol, D., Lapiedra, O., and Ducatez, S. (2020). "Cognition and adaptation to urban environments," in *Urban Evolutionary Biology*, eds M. Szulkin, J. Munshi-South, and A. Charmantier (Oxford: Oxford University Press), 16. doi: 10.1093/oso/9780198836841.003.0016

Szulkin, M., Munshi-South, J., and Charmantier, A. (2020). *Urban Evolutionary Biology*. Oxford; New York, NY: Oxford University Press. doi: 10.1093/oso/9780198836841.001.0001

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