Problem-solving and flexibility demonstrated in research on grackle cognition.

PCI Ecology Review of preprint #407

The preprint "Behavioral flexibility is manipulatable and it improves flexibility and problem solving in a new context." by Logan et al. (https://doi.org/10.32942/osf.io/5z8xs) is a product of much problem-solving and flexibility on the part of the researchers investigating flexibility itself as a biological salient and scientific construct. It is based on a preregistered "in principle" acceptance of their proposed research (reviewed by Maxime Dahirel and Andrea Griffin; 10.24072/pci.ecology.100019). I did not read through the extensive comments on earlier drafts of this paper, as I wanted to have a completely fresh perspective on the research.

The primary finding of this research on grackles, a bird species with a rapidly expanding geographic range, is that behavioural flexibility is not a static ability – whether expressed or not – but that animals can be "primed" for flexible responses by past experiences. Furthermore, the expression of flexibility appears to also influence other expressions of cognitive ability in the problem-solving domain. I think their approach is fascinating and as novel as they claim it to be. It is emerging that the expression of various cognitive traits is influenced by past or recent experience or environmental context (e.g., le Roux et al. 2019). The links between different cognitive abilities/constructs are currently ambiguous, to say the least; for example, exploration diversity may (Huebner et al. 2015) or may not (Lermite et al. 2017) be positively associated with problem solving ability. Therefore, this kind of research that explicitly examines the link between multiple traits is central to our understanding of how cognition works. It is clear that we cannot make assumptions about abilities or links between traits unless we examine numerous species and start to discern common patterns.

Logan et al. have here demonstrated that behavioural flexibility can be trained or improved in individual grackles, which then appears to influence innovative abilities in solving a multi-access puzzle box. These results have many potential implications, suggesting that experience in a fast-changing environment will affect problem-solving abilities in wild grackles. This aligns with research showing more innovative tendencies in urban vs rural species, based on the assumption that an urban environment is subject to more rapid changes in food availability and/or risk (e.g., Lowry et al. 2013).

In examining effect sizes, assessing innovation in more than one context, and adjusting their predictions to their experimental constraints (birds could not be tested indefinitely), they have done commendably thorough and transparent research on behavioural flexibility and innovation in wild-caught birds. They also remain cautious in their interpretations of the results. I agree with their interpretations and note that perhaps the only major constraint that was not considered is the potential influence of simple experience/ exposure to trials. I am assuming that the manipulated group of grackles had many more trials with the choice tests than the control group did, leading to a potential imbalance. I don't think absolute number of trials in which any bird participated was examined anywhere. The possible influence of exposure is something that could either be examined statistically or noted as a constraint/consideration in the interpretation of results. This is the only real caveat I have about the interpretation of their findings. My statistical skills are not significant enough to thoroughly interrogate all the modeling conducted in this dense, detailed work. As an ecologist with hands-on mixed modeling experience and an understanding of Bayesian principles, I can say that the statistical reasoning, interpretation, and multiple checks and balances appear to be thorough. I'd be happy if someone with more specific statistical expertise than mine could indeed confirm whether mistakes or statistical misinterpretations slipped in; this may have already been done with the approval of the original registered report.

Logan and her colleagues also demonstrate, perhaps unintentionally, how challenging it is to conduct research on behavioural flexibility and problem-solving in species not reared in a lab, and how important it is to constantly assess assumptions and predictions as the data unfolds. This thorough reassessment and flexibility on the part of the researchers would not have been clear without a previously evaluated registered report as guideline, and, to me, their entire project shows the value of peer-review and transparency at all stages of the research process. I recommend this preprint for acceptance.

I have some minor comments, below:

In the title, I would lean towards using the word "manipulable" rather than "manipulatable", but this is more a personal preference. Both words are applicable, though "manipulable" is the more common term and also, apparently, used in context of psychology rather than engineering.

Line 61: This paragraph discusses manipulative experiments, juxtaposing it with correlations/observational evidence. Is that what the studies in the preceding paragraph employed, or did they also do manipulative experiments? The way this is set up suggests that the experiments are in contrast with what was just mentioned, but it's not made explicit; it will help the reader to understand the novelty (or not) of the approach.

Line 346: "analyseis" is misspelled.

Table 4, p19 is unclear – what does each successive line represent?

Line 803 – "at **that** time" is misspelled, as is "were" earlier in the same sentence

Line 849: it is confusing to see "probability" as equivalent to "rate" per bird. Is this the likelihood of solving a particular locus, based on random probability, or based on observed rates of solving loci?

References

Huebner, F., & Fichtel, C. (2015). Innovation and behavioral flexibility in wild redfronted lemurs (*Eulemur rufifrons*). *Animal Cognition*, *18*(3), 777–787. https://doi.org/10.1007/s10071-015-0844-6

Lermite, F., Peneaux, C., & Griffin, A. S. (2017). Personality and problem-solving in common mynas (*Acridotheres tristis*). *Behavioural Processes*, *134*, 87–94. https://doi.org/10.1016/j.beproc.2016.09.013

Lowry, H., Lill, A., & Wong, B. B. M. (2013). Behavioural responses of wildlife to urban environments. *Biological Reviews*, *88*(3), 537–549. https://doi.org/10.1111/brv.12012