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Brain lateralization in lizard: the game of escape behavior at different hierarchical levels

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Increasing evidence is demonstrating that brain lateralization is not restricted to humans, several studies from fish to primates demonstrate that their occurrence may be widespread among vertebrates. It is now widely accepted that brain lateralization provides advantages for simultaneously performing different tasks without the risk of receiving contradictory orders from both brain sides. This explanation is meaningful from an individual and neurological point of view. Namely, each eye system could be specialized in developing a specific task such as recognition of novel object, selection of refuge, social behavior, foraging and predator avoidance, among others. Thus, individual lateralization is also advantageous in terms of energy saving that could be redirected to other tasks increasing the fitness at an individual level. From an evolutionary point of view it has even been suggested that the origin of lateralization might be as early as the appearing of visually controlled predation. However, being lateralized at hierarchical levels higher (population or species level) than individuals could have negative implications, especially if predators may predict prey behavior after multiple encounters. These conflicting pressures, namely between the advantages for individuals, and the disadvantages for populations could be concealed if higher-level lateralization would arise from the combination of lateralized behaviors of individuals which are mutually dependent. In the present study, we investigate the patterns of lateralization in different populations of lizards *Podarcis* using behavioural tests, with the aim of evaluating the incidence of lateralization at different hierarchical levels. Standardised experiments allowing lizards to equally select for either right or left refuges showed that the side of escape behavior is not universal in *Podarcis* at different hierarchical levels, some individuals and populations being lateralized with a consistent bias toward the refuge on the right. By contrast, some populations showed no refuge preference, with lack of lateralization mainly arising from the dominance of individuals with no side preference rather than from a mix of right- and left-biased individuals. When specimens from all *Podarcis* populations were considered together, a pattern for right-refuge preference arose. In conclusion, although refuge selection in *Podarcis* tends to be right biased at different hierarchical levels, some populations deviated from the rule showing no refuge preference. Further studies will be needed to infer the putative environmental pressures and the phylogenetic constraints subjacent to the lateralization of antipredator strategies in lacertids.

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