Mind the obstacle: Lateralization of detour behaviour in two invertebrate species

Alessandro Venditti, Andrea Caputi, Cinzia Chiandetti

Psychology Unit "Gaetano Kanizsa", Department of Life Sciences, University of Trieste, Trieste, Italy

Keywords: Lateralization, Detour, Crayfish, Cockroach, Invertebrates

Cerebral lateralization is a ubiquitous trait documented throughout all the branches of the phyletic tree, including that of invertebrate species [1,2]. Brain asymmetries that occur at the individual-level (i.e., individuals show either a left or right bias) are associated with several computational advantages [3,4]; however, mounting evidence is collected in favour of population-level lateralization (i.e., most individuals show the bias toward the same direction) [5] that has apparent disadvantages (e.g., the predictability of the individuals' responses). The adaptive benefit in the alignment of asymmetries within a population could lie in the facilitation of cooperation and defence behaviours and hence, should be especially evident in gregarious species [6,7].

We tested this hypothesis by investigating the detour responses of two sister families of invertebrate species: the cockroach (*Gromphadorhina portentosa*), a wingless hexapod, and the crayfish (*Procambarus clarkii*) a crustacean that can colonize new niches walking outside the aquatic environment. Both species navigate using the antennae, display aggressive interactions with conspecifics and multisensory social signalling [8,9], but cockroaches are considered gregarious while crayfish solitary.

In a formally identical labyrinth, animals could explore subsequent compartments. After the alignment of the body through a narrow corridor, a central physical obstacle forced a left-right detour choice in order to enter the next compartment. Few animals of both species displayed an individual-level lateralization (3 of the 102 cockroaches; 55 of the 202 crayfish). However, no population-level bias was evident in cockroaches, whereas crayfish showed a slight but consistent rightward bias in line with what observed in other vertebrate species [10].

Motivational rather than social aspects can account for the observed species' differences. Whilst cockroaches were extremely fast and their navigational goal was to find a sheltered place where to hide, crayfish explored systematically and slowly the environment in order to find a physical discontinuity where to engage in burrowing activity.

Acknowledgments: We thank Ilaria Santostefano for help with the testing. This work was partially supported by a UniTs-FRA2015 grant to CC.

1. Vallortigara G, Chiandetti C, Sovrano VA (2011). Brain asymmetry (animal). *Wiley Interdisciplinary Reviews: Cognitive Science, 2*: 146-157.

2. Frasnelli E (2013). Brain and behavioral lateralization in invertebrates. *Frontiers in Psychology, 4*: 939.

3. Rogers LJ, Zucca P, Vallortigara G (2004). Advantages of having a lateralized brain. *Proceedings of the Royal Society of London B: Biological Sciences, 271*: S420–S422.

4. Brown C, Western J, Braithwaite VA (2007). The influence of early experience on, and inheritance of, cerebral lateralization. *Animal Behaviour, 74*, 231-238.

5. Vallortigara G (2006). The evolutionary psychology of left and right: Costs and benefits of lateralization. *Developmental Psychobiology, 48*: 418-427.

6. Vallortigara G, Rogers LJ (2005). Survival with an asymmetrical brain: advantages and disadvantages of cerebral lateralization. *Behavioral and Brain Sciences, 28*: 575-633.

7. Bisazza A, Cantalupo C, Capocchiano M, Vallortigara G (2000). Population lateralisation and social behaviour: a study with 16 species of fish. *Laterality, 5*: 269-284.

8. Clark D, Beshear DD, Moore AJ (1995). Role of familiarity in structuring male-male social interactions in the cockroach *Gromphadorhina portentosa* (Dictyoptera: Blaberidae). *Annals of the Entomological Society of America, 88*: 554-556.

9. Aquiloni L, Miloš Buřič, Gherardi F (2008). Crayfish females eavesdrop on fighting males before choosing the dominant mate. *Current Biology, 18*: R462.

10. Bisazza A, Facchin L, Pignatti R, Vallortigara G (1998). Lateralization of detour behaviour in poeciliid fish: The effect of species, gender and sexual motivation. *Behavioural Brain Research, 91*: 157-164.