Evidence of population-level lateralization in a non-social crustacean, the crayfish *Procambarus clarkii*

Anna Antoniol, Andrea Caputi, Cinzia Chiandetti

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

Keywords: Lateralization, Reaching, Grasping, Crustacean, Procambarus Clarkii

Mounting evidence shows functional lateralization in invertebrates [1], with population-level asymmetries observed also in so-called solitary species [2]. Such results challenge a theoretical model postulating that group-level lateralization is more likely to evolve in social species [3].

To test this hypothesis further, we investigated whether *Procambarus clarkii*, a decapod crustacean considered a non-social species with remarkable burrowing capabilities [4], displays behavioural asymmetries while performing a fine motor manipulation task. Crayfish were placed in a rectangular environment, with a removable wall covering one side of the apparatus. Once this wall was removed, animals were free to reach a pellet of food placed beyond a transparent barrier, and only accessible through a small hole, thus requiring the crayfish to use a specific pereopod in order to reach the food. To evaluate lateralization, the pereopod used to grasp the food (left or right) was recorded, along with the time the animals needed to accomplish the task.

We observed that crayfish were not strongly lateralized at the individual-level (only 35 out of 122 animals displayed an individual level bias), and the time necessary to solve the task was not different between lateralized and non-lateralized animals (p=0.626). This result shows that no advantage is apparent for lateralized individuals [5, 6] and it could then be concluded that crayfish are equally skilled with both the left and the right pereopods. By contrast, the analysis on the whole population revealed that there is overall a slight but systematic preference for the use of the right pereopods to graps and pull the food pellet (p=0.01).

These results indicate that a further invertebrate species can display a certain degree of functional asymmetries within the population, although in absence of significant individual-level lateralization. Furthermore, the systematic preference for right manipulation observed in *P. clarkii* is similar to that of other vertebrate social species performing the same task [7] and other non-social tasks [8]. Therefore, our findings provide support to the fact that preferential limb use has a widespread occurrence and a long evolutionary history.

Aknowledgements: Thanks to Erica Bocchetta for help in testing the animals. The research is partially supported by a UniTs-FRA2015 grant to CC.

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

2. Benelli G, Donato R, Messing RH, Canale A (2015). First report of behavioral lateralization in mosquitoes: right biased kicking behavior against males in females if the Asian tiger mosquito, *Aedes albopictus*. *Parasitology Research*, *114*: 1613-1617.

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

4. Aquiloni L, Ilhéu M, Gherardi F (2005). Habitat use and dispersal of the invasive crayfish Procambarus clarkii in ephemeral water bodies of Portugal. *Marine and Freshwater Behaviour and Psysiology*, *38*: 225-236.

5. Rogers L. J (2000). Evolution of hemispheric specialization: advantages and disadvantages. *Brain and Language*, *73*: 236-253.

6. Magat M, Brown C (2009). Laterality enhances cognition in Australian parrots. *Proceedings of the Royal Society B, 276*: 4155-4162

7. Guven M, Elalmis DD, Binokay S, Tan U (2003). Population-level right-paw preference in rats assessed by a new computerized food-reaching test. *International Journal of Neuroscience*, *113*: 1675-1689.

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