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Laterality for the next decade: Computational ethology and the search for minimal condition for cognitive asymmetry

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ABSTRACT

In this comment to Ocklenburg et al.'s paper I stressed the contribution that computational ethology can provide to the accurate tracking of lateralized behaviour in a variety of species; I also discussed how current interest in so-called «minimal cognition» may help to disentangle shared and species-specific mechanisms of brain and behavioural asymmetries.

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First of all, let me applaud to this scholarly and thoughtful review by Ocklenburg, Berretz, Packheiser, and Friedrich (2021) dealing with laterality research entering the next decade. After reading it, my first thought was something like: Well, that's fairly complete and very sensible, I have nothing to add to it or comment on it ... Then, after some re-reading I realized there are two points that possibly deserve a short comment.

The first concerns new methodologies for laterality research. Ocklenburg et al. (2021) rightly stressed the role of machine learning, mainly from the point of view of theoretical integration and advances in parallel with network neuroscience. However, deep learning is also making a small revolution in promoting the development of so-called «computational ethology» (Anderson & Perona, 2014), which makes use of sophisticated machine learning techniques to allow tracking of behaviour with an unprecedented precision and speed (such as the DeepLabCut toolbox, Mathis and Mathis, 2020). Just to give a specific example, people (like me) interested in asymmetries in eye use in birds have been faced with the issue of painstakingly recording frame-by-frame the use of the lateral and frontal field of vision of birds during their performance of different tasks (e.g., Vallortigara, Cozzutti, Tommasi, & Rogers, 2001). Now, some young scientists from my lab have

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developed fancy applications to make it all automatized using DeepLabCut versions of it for chicks and zebrafish (e.g., Josserand & Lemaire, 2020; Josserand et al., *in prep*). For sure these computational ethology techniques would also contribute to solving the replication crisis with regards to the difficulties associated with tracking of animal behaviour.

My second comment is more theoretical. Yes, we have come a long way from the old idea that lateralization was unique to the human species, and we now recognize it as a fundamental principle of organization of the nervous system of Bilateria (Rogers & Vallortigara, 2015). Still, we do not know whether some aspects of lateralization could be in some way special to human beings. Of course, I am not referring here to the presence of lateralization for functions that are unique to humans, say language (to study this would have the same value as discovering lateralization in the way electric fish communicate with each other—something that humans of course do not possess). The issue I am discussing here is related to the possibility that asymmetry in itself could in some way show some special feature in our species. This is alluded to by Ocklenburg et al. (2021) where they stated “humans usually demonstrate more pronounced asymmetries at the population level, and as such, these lateralization patterns might be unique” (p. 15). I’m not really sure I would agree with that. There are examples of asymmetry being as strong in non-humans as it is in humans, e.g., footedness in cockatoos, laterality of odour response in bees (see for reviews Rogers, Vallortigara, & Andrew, 2013; Vallortigara & Rogers, 2020; Vallortigara & Versace, 2017). It has been claimed sometimes that animal studies reporting population-level asymmetries, particularly those involving non-human primates, would not possess the same statistical power as studies in humans, some of which are based on large samples. However, there is now evidence for lateralization in large samples even in non-human primates (e.g., Meguerditchian, Molesti, & Vauclair, 2011, 2015). Besides studies with non-human animals usually allow precise experimental control on experiential variables (even in utero or in ovo, e.g., Chiandetti & Vallortigara, 2019) and unprecedented spatio-temporal resolution (e.g., with calcium imaging Rigosi et al., 2015, or molecular biology Messina, Boiti, & Vallortigara, 2020, July 21) to study the underlying mechanisms which would not be possible in humans.

I believe the recent interest in lateralization in invertebrates (Frasnelli, Vallortigara, & Rogers, 2011, 2012; Frasnelli et al., 2014) offers an opportunity to identify the minimal complexity of a neuronal organization that enables lateralized processing. This may be part of a more general trend in cognitive sciences, because of increasing interest for so-called “minimal cognition” (i.e., cognition not only in insects but also in arachnids, crustacea, cephalopods, gastropoda, worms, bacteria, protists, and plants, see for an example the recent Special Issue of the journal *Biochemical and Biophysical Research Communications* on “Rethinking Cognition” edited by Lucia Regolin and myself,

Regolin & Vallortigara, 2020). The question is thus, where (and why) should we find cognitive laterality in living creatures? I have added «cognitive» here to insist on the biological function of lateralization (we know that left-right asymmetries are present as chirality in molecules and even sub-atomic entities). Apart from adaptive specializations, such as language, that as I mentioned above maybe unique of some species, we know that even so-called «higher» cognition can be apparent in the invertebrate brains (see e.g., Bortot, Regolin, & Vallortigara, 2020, December 3; Vallortigara, 2020). Searching for a minimal condition for laterality to be present can perhaps help us to better consider the issue of whether human laterality has something special at either the individual or population level.

Disclosure statement

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