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Editorial

Special Issue on Brain Asymmetry in Evolution

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1. Introduction

The brain is lateralized morphologically and functionally, with unique species-related specifications [1]. Asymmetrical intra- and interhemispheric neuronal connectivity, in particular, is organized in higher mammals, that is, humans and non-human primates, in relation to preference for hand/paw usage, emotion, cognition, and language [1]. It is noticeable that brain lateralization is disturbed in human neurodevelopmental disorders with cognitive impairments and/or social deficits such as autism, schizophrenia, dyslexia, attention deficit hyperactivity disorder, and specific language impairments [2]. This Special Issue highlights the morphological and functional lateralization of the brain in various vertebrate species to assess the significance of brain asymmetry in evolution. The issue includes six publications appearing in *Symmetry*: one review article and five original papers that focus on the unique asymmetric aspects of brain morphology and function in various vertebrate species, such as zebrafish, rats, ferrets, macaque monkeys, and humans.

2. Brief Overview of the Contributions

A review article by Sawada [3] summarizes the asymmetry of cerebral sulcal infolding in macaque monkeys in comparison with other primate species, including humans. The review discusses how sulcal asymmetry in the precentral cortex is right-lateralized in macaque monkeys but left-lateralized in chimpanzees and humans. Such diverse cortical lateralization may be associated with shifting the preferred handedness from the left or none to the right between Old World monkeys and great apes.

In the original article by Eckert et al. [4], which includes retrospective data from 212 children, the structural asymmetry of language-related regions of the cerebral cortex in normative pediatric samples is investigated. In this study, through deformation-based and persistent homology approaches using T_1-weighted magnetic resonance (MR) images, the authors reveal topological asymmetry in language-related cortical regions. Right asymmetry is noted in the superior temporal sulcus, particularly in males and older children. The findings, to a large extent, are consistent with the results obtained from whole-brain voxel-based asymmetry.

The next original article by Horiuchi-Hirose and Sawada [5] examines the change in left/right frontopolar prefrontal cortex (PFC) activity with states of anxiety using near-infrared spectroscopy. In this study, differential levels of state anxiety are evoked in 26 healthy male volunteers performing two difficult levels of mental arithmetic tasks. Increasing task difficulty reduces performance in the moderate- and high-level anxiety groups and facilitates frontopolar PFC activity in both the left and right hemispheres, with the dominant side shifting from left to right.

In the original article by Sakaguchi and Sakurai [6], a split-brain experiment, cutting the interhemispheric connections including the hippocampal commissure, is conducted in rats to assess the contribution of the left–right hemispheric interaction to short- and long-term memory formations. A week after the dissociation of interhemispheric connections, rats undergo spontaneous alternation and novel preference tests to evaluate short-term memory and object location and plus-maze tests to assess long-term memory. The findings

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reveal that commissural connections between the left and right hippocampi are essential for short-term memory but not long-term memory.

In the next original article by Sawada and colleagues [7], the authors investigate cerebellar lobular morphology in young adult ferrets, and report that these have asymmetric features similar to humans but not observed in rodents. For the study, anatomical MR images are acquired from the fixed brains of the ferrets and rendered in 3D to enable detailed visualization of the surface morphology of the cerebellar cortex. Poor sublobular development and additional indentations are defined as asymmetric hallmarks. The four cerebellar transverse domains are divided according to a previous study [8]. The relationship between volume laterality and the incidence of asymmetric hallmarks is estimated for each transverse domain. The left-lateralized domain volume consisting of lobule IV and ansiform lobules is associated with significant right-over-left incidences of poor development and/or additional sulcus emergence.

The last article in the issue is by Petrazzini et al. [9], and focuses on the side bias of binary choice for two alternative stimuli observed while performing animal behavior testing in zebrafish. The degree and direction of brain lateralization are assessed using a detour test preceding operant conditioning tasks. The operant conditioning task performances on the binary choices are correlated with the detour-test-defined pre-existing preferred side. It is noted that the behavior does not change even after extensive training of 500 trials. These findings reveal that brain lateralization has a large influence on the side bias of behavior testing in zebrafish.

3. Conclusions

In this Special Issue, functional brain lateralization at the individual level is reported as an anxiety-associated lateralized frontopolar PFC activity in humans [5] and as a side-biased binary choice in zebrafish [9]. These are involved in individual cognitive abilities when performing mental arithmetic and operant conditioning tasks [5,9]. At the population level, brain lateralization is defined as a characteristic that is expected to appear across mammalian species (short-term memory) [6] and to have developed through human evolution (language) [4]. Conversely, a complex asymmetric surface morphology develops in the cerebral cortex of primates [3] and the cerebellar cortex of carnivores [7]. Such asymmetric brain morphology is disturbed in human patients or animal models of neurodevelopmental and/or psychotic disorders such as autism and schizophrenia that involve cognitive impairment [2]. I hope that the findings of the studies featured in this Special Issue will give readers insight into the significance of brain lateralization throughout the evolutionary trajectory of vertebrates.

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Conflicts of Interest: The author declares that the research was conducted without any commercial or financial relationships that could be construed as potential conflicts of interest.

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