LETTER

An ancestral anatomical and spatial bias for visually guided behavior

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Human behavioral asymmetries are commonly studied in the context of structural cortical and connectional asymmetries. Within this framework, Sreenivasan and Sridharan (1) provide intriguing evidence of a relationship between visual asymmetries and the lateralization of superior colliculi connections—a phylogenetically older mesencephalic structure. Specifically, response facilitation for cued locations (i.e., choice bias) in the contralateral hemifield was associated with differences in the connectivity of the superior colliculus. Given that the superior colliculus has a structural homolog—the optic tectum—which can be traced across all Vertebrata, these results may have meaningful evolutionary ramifications.

Even the oldest vertebrates display asymmetries in visually guided responses. Lungfish, the closest extant predecessor of the first land-dwelling vertebrates, show biases in their sidewise movements depending on their percept: When fleeing from oncoming predators, they deviate left, whereas during foraging behavior they commonly turn rightward (2). Avian species also show asymmetries in visually guided behavior that closely resemble human visual choice bias. Due to the full crossing of the optic chiasm, visual input entering one hemisphere can be hindered by occluding the contralateral eye. When doing this, pigeons show higher success rates in grain–grit discrimination tasks only when they have access to the right eye. Moreover, pigeons with higher degrees of visual asymmetry display more successful foraging behavior under regular, binocular circumstances (3). Concordantly, both chicks with normal cerebral asymmetries (4) and peociliid fish selectively bred for stronger visual lateralization (5) show an advantage in simultaneous predator monitoring and foraging. Hence, behavioral asymmetries for visually guided responses are not unique to humans and may constitute an important advantage for predator avoidance and foraging that has been conserved throughout evolution.

In line with Sreenivasan and Sridharan (1), species that display asymmetries in visually guided behavior also show asymmetries in mesencephalic connections. For instance, zebrafish show leftward asymmetries between mesencephalic and epithalamic structures, in particular between the left dorsal nucleus interpeduncularis and the left lateral habenula which responds mostly to visual input (6, 7). In pigeons, the tectofugal pathway which is involved in visual processing is left-lateralized. Precisely the left visual thalamic nucleus receives stronger input from the contralateral optic tectum than the right nucleus (8). Hence, mesencephalic asymmetries are evolutionary conserved, although their appearance differs across species.

The study by Sreenivasan and Sridharan (1) reveals that asymmetries in the phylogenetically older mesencephalon affect visually guided responses in humans. The cause of mesencephalic asymmetries, for example in pigeons, has been revealed to be driven by environmental factors: During embryogenesis there is stronger photostimulation of the right eye (9). Whether these mesencephalic connectional asymmetries are shaped by environmental factors or are genetically determined in humans remains to be explored and could provide useful insight into the mechanisms of human behavior. This may allow for a more complete perspective regarding the circumstances under which evolutionary adaptations in cognition and brain anatomy arose.

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