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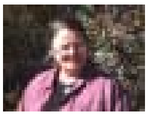
Survival with an Asymmetrical Brain



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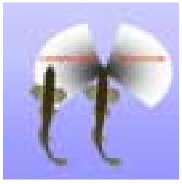
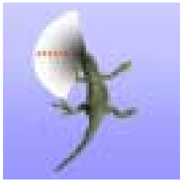
1. Brain asymmetry and side biases

Asymmetry of brain function manifests itself as side biases for responding in a number of species. There is a general tendency to respond to conspecifics on the left side, either to approach or to attack, and to do so rapidly without detailed processing. Responses to the right side are made after more consideration than those to the left and, for example, are used to select food objects and respond to stimuli after allocating them to categories rather than on an individual basis.



Some species of fish have been shown to prefer to swim with a conspecific on the left side while monitoring a predator on the right side (right eye) – shown by Bisazza et al. (1999).



The lizard, *Anolis sp.*, has a preference to attack conspecifics on its left side –shown by A. W. Deckel (1995).

Toads attack conspecifics to the left and strike preferentially at prey on the right - Robins et al. (1998) and Vallortigara et al. (1998).

Chicks have higher levels of attack when tested monocularly with the left eye open and they learn to discriminate grain from pebbles only when tested with the right eye open – Rogers (1996).

The gelada baboon also has higher levels of attack to the left side than to the right side – Casperd and Dunbar (1996).

2. Disadvantages

These side biases have obvious disadvantages for survival (e.g. reduced responding to conspecifics on the right side and to prey on the left side) but the ubiquity of this characteristic suggests that it confers some evolutionary advantage.

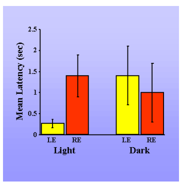
Therefore, it is important to see whether there are any advantages in having an asymmetrical brain.

First, we should note that there are two forms of asymmetry: 1) present in individuals but not in the population (i.e. about half of the individuals biased in one direction and the other half in the opposite direction), and 2) present in individuals and in the population (all biased in the same direction).

3. Vigilance is enhanced by having an asymmetrical brain

It has long been assumed that differential specialisation of the hemispheres enhances neural (and cognitive) capacity. Testing chicks with asymmetrical and symmetrical brains has provided evidence in support of this hypothesis.

Chicks hatched from eggs exposed to light just prior to hatching are lateralised for attack and feeding responses, as shown above. Chicks hatched from eggs incubated in the dark are not lateralised for these responses. Light exposure causes lateralisation to develop because the embryo is turned in the egg so that it occludes its left eye, whereas light entering through the shell can stimulate the right eye (Rogers, 1990). The light enhances the development of visual neurones receiving input from the right eye and projecting to the forebrain (Rogers, 1996).



When tested on a task requiring dual attention, lateralised chicks perform better than nonlateralised ones. The chicks were feeding when a model predator (a hawk model) was rotated overhead. The light-exposed chicks had a short latency to detect the predator (indicated by ceasing to feed) when it was in the left visual field. Dark-incubated, nonlateralised chicks were slower to detect the predator irrespective of the visual field in which it was present.

Therefore, the chicks with asymmetry were able to attend to feeding and monitor overhead (with the left eye) for predators. Symmetry reduced this ability of attending to two tasks at once.

This advantage of lateralisation would have no requirement for all (or most) members of a population to be lateralised in the same direction

4. Asymmetry at the population level is important for social species

Chicks hatched from eggs exposed to light (i.e. lateralised) form more stable hierarchies than chicks hatched from eggs incubated in the dark (not lateralised) (Rogers and Workman, 1989). Here a population bias of lateralisation might aid predictability (i.e.. chicks might decrease aggression by not approaching another on the left side, provided all individuals are lateralised in the same way).

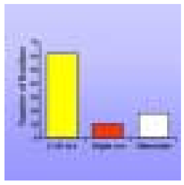
Recently, A. Bisazza , G. Vallortigara and colleagues (1999) have found that social species of fish are lateralised at the population level, whereas nonsocial species are not. They suggest that population asymmetry may assist shoaling – when disturbed by a predator all individuals would turn in the same direction and so maintain the integrity of the shoal. A predator might exploit this bias but the advantage of shoaling may out weigh any such disadvantage.

Ritualised fighting might rely on a population bias for leftwards attacking. In fact, Drews (1996) found that wild baboons (*Papio cynocephalus*) receive more injuries on the right side of the head region, consistent with Jarman's (1972) earlier report of more scars on the right side of the pelts of impalas. Of course, these side biases may depend on the attacker or the one attacked. Also relative positioning at the time of receiving the injury would be important. Nevertheless, these observations of injury patterns indicate that field observations of possible lateralisation in agonistic encounters would be interesting

5. Reporting lateral biases in field observations

Further tests need to be designed to assess the advantages and disadvantageous of lateral biases for survival in natural contexts. At the same time, it is likely that more lateral biases will be observed in behaviour in the field.

For example, Rogers and Kaplan have found that Australian kookaburras display preferential use of the left eye (right hemisphere) to scan the ground for moving prey. This is consistent with the right hemisphere's role in processing topographical information, as shown in the chick (Rashid and Andrew, 1989). Each time a kookaburra was observed fixating the ground, typically when perched on a telegraph wire, the eye so used was noted. A strong preference for the left eye was found.

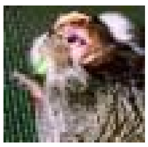


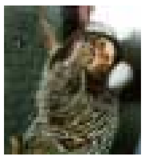
6. Hand preference and exploration in primates

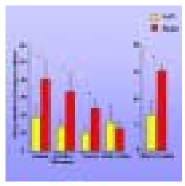
Hand preference for picking up and holding food to the mouth is related to exploration in primates (in chimpanzees, Hopkins and Bennett, 1994; in marmosets, Cameron and Rogers, 1999). Right-handed subjects are more active in exploring novel objects and environments than left-handed ones.

Left- and right-handed marmosets (determined, in the home cage, as the preferred hand for picking up food and taking it to the mouth) were released into a novel environment, a large room with structures for climbing and novel objects and odours. The right-handed marmosets were more active and touched more objects.

It would appear that hand preference for feeding in a relaxed state reflects preferential activation of the contralateral hemisphere and so may be associated with more general aspects of behaviour. If these results can be extrapolated to marmosets in the natural environment, we can predict that populations comprised mainly of right-handers may be more likely to colonise new environments and more likely to accept new foods than populations of left-handers. Depending on the context, species may vary in the proportion of left- and right-handed individuals and hand preference may reflect demands for different levels of exploration or some related ability.







Acknowledgments

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