CONSISTENT MOTOR LATERALITY IN CALIFORNIA SEA LIONS

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Society for Marine Mammalogy
Vancouver, British Columbia, November, 2001

Introduction

In humans, such traits as left- and right-handedness are enduring characteristics of individuals, and it is precisely their stability that accounts for their central place in theories pertaining to lateral cerebral dominance. Similar stability of left-right behaviors in marine mammals would likewise carry implications about cerebral asymmetry in these species. For this reason, we tested for consistent left/right motor biases in captive California Sea Lions. We assessed lateral bias in two settings—in foot-fall patterns when running and in direction of circling when swimming.

Procedure

Thirty two adult California Sea Lions (14 female, 18 male), housed at five different Seaquariums, served as subjects. We made observations on each of two behaviors and all subjects were observed at least two times on each measure. For half of the subjects, we completed at least one observation per measure each week for ten weeks.

Circling While Swimming. For a one minute period, the observer noted the number of complete circuits that each Sea Lion made in a counterclockwise direction (scored as leftward) or clockwise direction (scored as rightward) in its holding pool. Figure 1 presents an example video sequence in which two sea lions are circling leftward while one is simultaneously circling rightward.

Running Gait. Each Sea Lion was videotaped while running, once directly toward, and once directly away from, the camera. The leading front flipper and asymmetrically swung hind flipper were noted in subsequent video analysis. Separate ratings by two independent blind observers achieved very high inter-rater reliability on these observations. Figure 2 presents an example of a sea lion running with a left rear flipper lead.

For each measures, a numerical score was computed as the number of rights divided by the total number of lefts plus rights (R/(L+R)). For comparisons across behaviors, the mean score across observations was computed separately for running and swimming.

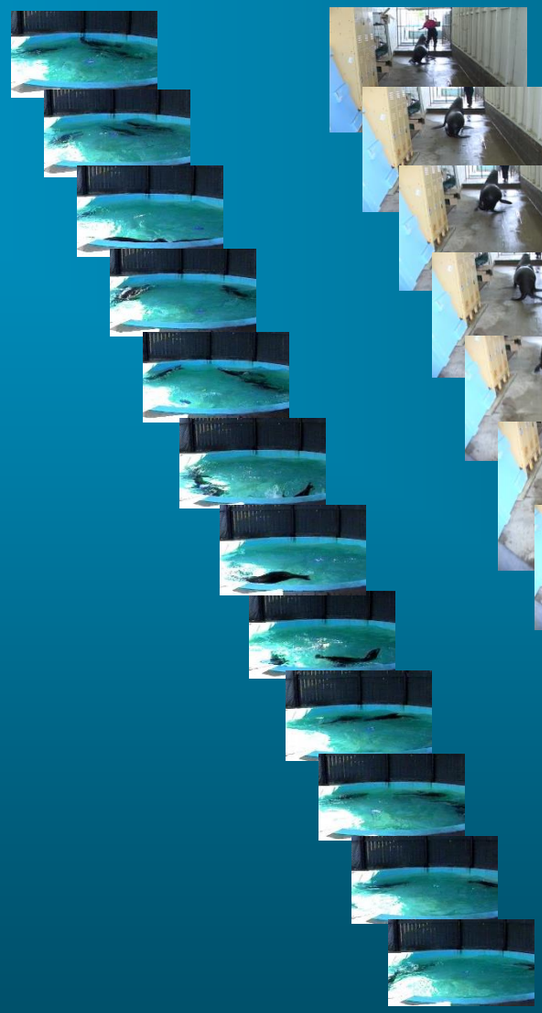

Figure 1. Example video sequence in which two sea lions are circling leftward while one simultaneously circles rightward.

Figure 2: Example video sequence depicting a sea lion running with a left rear flipper lead.

Results

High within measure reliability.
Both measures were characterized by very high reliability across observations-both within and across days ($r = 0.7+$, $p < .0001$). That is, individual Sea Lions had distinct preferences to favor their left or right flipper leads and to prefer left or right circling in a way that was very consistent within animals over time.

Lack of population bias.
Across the sample, there was no significant directional bias on either task—that is, on both measures there were approximately equal numbers of right- and left-biased animals. Neither were there reliable differences between the sexes on overall direction of bias.

Low between measure correspondence.
Across all subjects, the correlation between the two forms of locomotion (mean lateral bias across observations on each measure) was 0.24 (ns).

Sex differences.
Although, the reliability across observations was high and statistically significant in both sexes, there were differences between them that approached (but did not reach) statistical significance. Specifically, there was greater consistency in running flipper lead in females ($r = 0.8$ to 0.99) than in males ($r = 0.5$ to 0.7). And, by contrast, there was greater consistency in direction of swimming in males ($r = 0.$ 7 to 0.8) than in females ($r = 0.5$ to 0.6). Moreover, the inter-measure correlation was higher in females ($r = 0.37$) than in males ($r = 0.11$).

Discussion

The very high day-to-day reliability for the lateral bias shown in each form of locomotion implies that individual Sea Lions are characterized by enduring asymmetries in the neural substrate that underlie their locomotion. However, this asymmetry appears to vary from animal to animal and does not show the type of population-wide bias evidenced by the predominant right-handedness of humans.

Moreover, the lack of concordance between the biases shown in running and swimming suggests the absence of any consonant cerebral asymmetry in this species. In this regard, the California Sea Lion more closely corresponds to other non-human mammal species such as the rat (Noonan and Axelrod, 1989), wherein no directional concordance has been found between lateral biases on land and while swimming.

The possible finding of sex differences in the degree of concordance between our laterality measures is also reminiscent of a somewhat similar pattern in rats (and in humans). However, we will need to add additional subjects to our analysis before a confident statement can be made about any real sex differences in sea lions.

More importantly, now that we know that individual sea lions possess enduring lateral biases, it will be interesting in future studies to see if left- and right-biased animals characteristically differ on measures of cognitive processing in ways that may be analogous to such differences in humans.

Acknowledgements

The authors wish to thank Nic Hayne, Dave Elliott and John Holer of Marineland of Canada; Emily Insalaco, Michelle Grady and Jennifer Humphrey of the Aquarium of Niagara; Marci Romagnoli, Tim Hoffland, Melanie Rood and Moby Selongi of Marine Life Productions; Susan DeFalco and Jeff Wyatt of the Seneca Park Zoo; all for their generous contributions of time, logistical support and the access to animals that made this investigation possible.