Is an animal's agility affected by the position of its eyes?

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New research from scientists in Liverpool has revealed the relationship between agility and vision in mammals. The study, published today in the *Journal of Anatomy*, sampled 51 species to compare the relationship between agility and vision between frontal eyed species, such as cats, to lateral-eyed mammals such as rabbits, to establish if the positioning of the eyes resulted in limitations to speed and agility.

"Footballers do it, cheetahs do it, and even sedentary academics can do it. We all have the ability to visually track an object whilst on the move and you don't give a second thought to the effort involved," explained co-author Dr Nathan Jeffery from the University of Liverpool. "As you walk or run your head swings up and down, tilts from side to side and rotates. Three semicircular canals of fluid found on each side of the skull sense these movements, one for each direction. These then send signals via the brain to three pairs of muscles that move the eyeball in the opposite direction and ensure that you can keep your eye on the ball, gazelle or the beer in your hand."

This process, known as the vestibulo-ocular reflex, is affected by the directions sensed by the canals and the pull directions of the eye muscles. In mammals, the eyes can be on the side of the head, as with rabbits, or at the front of the head like in cats, however the position of the canals is basically the same. In some mammals the brain must do extra calculations to adjust the signal from the canals to match the different pull directions of the eye muscles.

"In our study we wanted to find out if these extra calculations placed any limitations on how fast an animal could move," said co-author Phillip Cox. "We asked if there could be a point whereby, if an animal moves too quickly it could result in the brain being unable to adjust the signals from canal to muscle planes, which in turn would result in blurred vision." The work was funded by the Biotechnology and Biological Sciences Research Council.

The team used MRI scanners to analyse the arrangement of canals and eye muscles in 51 species of mammal including giraffes, camels and zebra, tree shrews, bats and sloths. Astonishingly, the team found that the position of canals and eye muscles had no effect on the ability to see clearly at speed. In theory, a Sloth could travel as fast as a Cheetah without blurring its vision.

The team also found evidence suggesting that the role of the extraocular muscles switches with changes of eye position. For instance, muscles that make up-down compensatory movements in frontal-eyed species appear aligned for torsional movements in lateral-eyed species. Before this, scientists had assumed that major rewiring of the connections was essential to adapt the reflex to changes of eye position.

"Switching between muscles offers an economical way of adapting the vestibulo-ocular reflex to changes of eye position without major rewiring of the connections or changes of canal orientations," concluded Dr Jeffery. "The mammalian brain can apparently cope with the extra demands placed on it whether the eyes are at the front, side or almost at the back of the head."

More information: Jeffery.N, Cox.P,“Do agility and skull architecture influence geometry of the mammalian vestibule-ocular reflex?” Journal of Anatomy, Wiley-Blackwell, February 2010, DOI:10.1111/j.1469-7580.2010.01211.x

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