

Cat righting reflex

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The **cat righting reflex** is a cat's innate ability to orient itself as it falls in order to land on its feet. The righting reflex begins to appear at 3–4 weeks of age, and is perfected at 6–7 weeks.^[1] Cats are able to do this because they have an unusually flexible backbone and no functional clavicle (collarbone). The tail seems to help but cats without a tail also have this ability, since a cat mostly turns by moving its legs and twisting its spine in a certain sequence.^[2]

Technique

After determining down from up visually or with their vestibular apparatus (in the inner ear), cats manage to twist themselves to face downward without changing their net angular momentum. They are able to accomplish this with these key steps:

1. Bend in the middle so that the front half of their body rotates about a different axis from the rear half.
2. Tuck their front legs in to reduce the moment of inertia of the front half of their body and extend their rear legs to increase the moment of inertia of the rear half of their body so that they can rotate their front by as much as 90° while the rear half rotates in the opposite direction as little as 10°.
3. Extend their front legs and tuck their rear legs so that they can rotate their rear half further while their front half rotates in the opposite direction less.

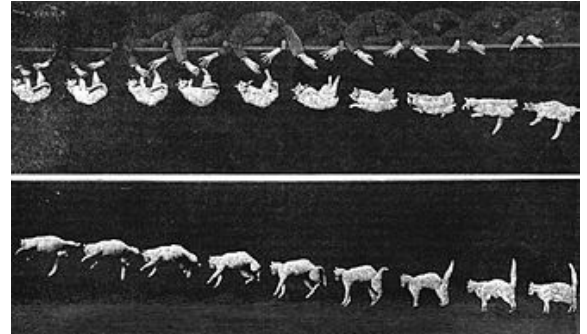
Depending on the cat's flexibility and initial angular momentum, if any, the cat may need to perform steps two and three repeatedly in order to complete a full 180° rotation.^{[3][4][5]}

Terminal velocity

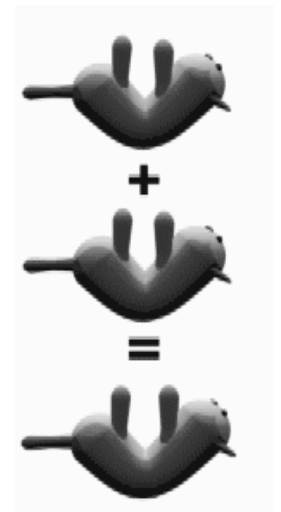
In addition to the righting reflex, cats have other features that reduce damage from a fall. Their small size, light bone structure, and thick fur decrease their terminal velocity. While falling, a cat spreads out its body to increase drag.^[6] An average-sized cat with its limbs extended achieves a terminal velocity of about 60 mph (97 km/h), while an average-sized man reaches a terminal velocity of about 120 mph (190 km/h).^[7] A 2003 study of feline high-rise syndrome found that cats 'orient [their] limbs horizontally after achieving maximum velocity so that the impact is more evenly distributed throughout the body'.^{[8]:311}

Injury

With their righting reflex, cats often land uninjured. However, this is not always the case, since cats can still break bones or die from extreme falls. In a 1987 study, published in the *Journal of the American Veterinary Medical Association*, of 132 cats that were brought into the New York Animal Medical Center after having fallen from buildings, it was found that the injuries per cat increased depending on the height fallen up to seven stories, but decreased above seven stories. One cat lived from falling 57 stories with only a chipped tooth.^[9] The study authors speculated that after falling five stories the cats reached terminal velocity and thereafter relaxed and spread their bodies to increase drag. However, critics of the study pointed out a survivorship bias in that instantly fatal falls were not included (as an already dead cat would not be taken to the vet), questioning the authors' conclusion that the injury rate declined for higher falls.^[9] A 2003 study of 119 cats concluded that "Falls from the seventh or higher stories, are associated with more severe injuries and with a higher incidence of thoracic trauma."^[10]



Falling Cat – images captured in a chronophotography by Étienne-Jules Marey (shown in the journal *Nature*, 1894)



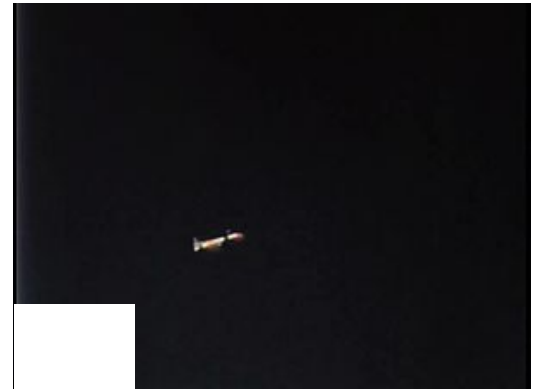
Schematic animation of the motion involved

See also

- Falling cat problem – the mathematical problem of explaining the physics of the cat righting reflex
- High-rise syndrome
- Buttered cat paradox – a humorous combination of two proverbs

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Cats falling at normal gravity and with no gravity

Further reading

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External links

- The surprisingly complicated physics of why cats always land on their feet (<https://arstechnica.com/science/2019/12/the-surprisingly-complicated-physics-of-why-cats-always-land-on-their-feet/>)
- Why cats land on their feet (<http://www.petplace.com/cats/why-cats-land-on-their-feet/page1.aspx#>)
- National Geographic video on the cat righting reflex (https://web.archive.org/web/20160420062227/http://video.nationalgeographic.com/video/cats_domestic_ninelives)
- The miracle of the falling cat (http://scienceblogs.com.br/brazillion/2009/06/the_miracle_of_the_falling_cat.php)
- How do cats always land on their feet? (<http://www.bbc.com/earth/story/20160401-how-do-cats-always-land-on-their-feet>) Super slow motion video of the African caracal.
- Slow Motion Flipping Cat Physics (<https://www.youtube.com/watch?v=RtWbpyjJqrU>)

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