



Feline Pesematology :



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Methods

The majority of this study depends on some previously done studies by the Manhattan Animal Medical Center in association with the American Veterinary Medical Association and some more general studies of cat physiology that are difficult to properly attribute to a particular source due to how wide-spread they are. The anatomy of cats for example, is a subject for a very wide set of anatomy courses in schools across the nation. Certain reflexes that are common in cats as well as a wide variety of other living creatures are also fairly common knowledge. The mathematical equations for a free-fall from a surface on Earth are all very common as well.

The mathematical equations in this study will be done with MathCad (because it is easy to obtain and free for me), although since the experiment is mostly hypothetical the equations will mean more symbolically. No additional resources will be needed.

Motivation

Like many other people, I am amused by the outcome of the previously mentioned experiment done in this field, and I wanted to find out if my initial assumptions regarding the reasons behind this phenomenon were correct or not. I want to determine the logical basis for the conclusions of those prior experiments and thusly determine whether the results are sound or if they are sound or occurred by random chance. Some of this information could be used to increase my personal odds of survival in the unlikely case I ever fell out of a building. Perhaps, in some professions where people tend to fall often, such as window washers or paratroopers, this information may come in handy and save some lives. The general scientific community however, probably does not stand to benefit from this research.

My research into this topic, of course, depends on the experiments done on the subject matter by other institutions, because I am clearly not going to go dropping cats out of buildings. I will citing a variety of outside sources and a few commonly known pieces of information to establish my reasoning and prove the outcomes of the previous falling cat experiments.



Abstract

The study of "feline pesematology" is a title given to the odd but recently somewhat popular scientific field that studies the properties of falling cats. This field has attracted a significant amount of attention lately due to its particularly bizarre findings. One study done by the Animal Medical Center in Manhattan concluded that when dropped from a height of 7-32 stories cats survived their falls 95% of the time, but when dropped from a mere 2-6 stories the cats only survived 90% of their falls, indicating that cats are more likely to survive higher falls than lower ones. A number of factors including terminal velocity, drag force, and basic psychology contribute to this phenomenon. This poster will examine some of the mathematical, physical, and psychological reasons why cats are more capable of surviving long falls than short ones.

Results

Let's begin by logically portraying the outcome of the experiment this study depends on. In the Manhattan Center's study, as a percentage, nearly two times as many cats died from falls out of heights that were lower than 7 stores versus heights that were 7 stores or higher. A sample size of roughly 120 cats indicates that there is minimal random error in their statistics. Therefore, we can conclude that a higher altitude results in a greater chance of survival for cats. This also means that a longer time in the air increases odds of survival.

To begin, let's calculate the theoretical terminal velocity of a falling cat, given the average weight of a domestic cat to be about 5 kilograms and the average dimensions to be about 46cm x 25cm. We know the gravitational field of earth accelerates at a rate of 9.8 meters per second squared, and given what we know about a cat's dimensions we can make a good guess for the drag force on a cat.

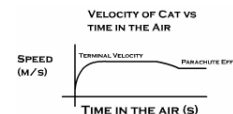
Drag force is equal to: $F_D = \frac{1}{2} \rho v^2 C_d A$

We'll take Rho, the density of air, to be about 1.184, and C, the drag coefficient, to be about 1.15, because cats are not very aerodynamic. The area of a falling cat, let's say, is about .115 meters squared, from our cat dimensions above. The force of gravity on the cat is simply mass times gravity, in this case equal to 49 Newtons. Terminal velocity would be achieved when the force of gravity equals the force of drag, which, if we do the calculation, will happen at v= 25 meters per second, which is roughly 90 km/hour, or 56 mph. This over twice as slow as the human terminal velocity, a bone-crushing 56 meters per second. Accounting for some of the slowing caused by the drag force and gravity's constant acceleration, a cat could achieve its terminal velocity in a little over 3 seconds, which means that realistically, cats will hit the ground at about the same speed after being in the air for over 3 seconds, no matter how high up they started from. Based upon this, it can be concluded that cats dropped from heights above the 6th story all hit the ground at the same speed. Most of the cats dropped from the second to sixth stories also probably hit the ground at roughly the same rate, so why were there so many more fatalities at lower heights than higher ones?

A lot of the fatalities may have to do with the method cats use to jump or right themselves after a fall. A cat's primary objective when falling is to distribute the force of impact to all 4 limbs, converting most of the impact force into the inward joint motion of the legs. When a cat detects that it is falling, it goes through a series of steps to ensure a proper landing, beginning with determining which direction is up. After the cat has established which direction is up, it rotates its head into the right-side-up position and moves its front legs closer to the head to shield it from impact. The cat will then proceed to twist its spine until the front half of the body is in line with its head, then bend its rear legs into impact position and twist the remainder of its body into the right-side-up position. Although cats can typically do this very quickly, those cats that died falling very close to ground level may have not had time to complete their full righting procedure, resulting in their not landing on all 4 legs as intended. This perhaps, caused fatal injuries in some of the felines. This process is pictured all over the board. Another cause of cat fatalities on the lower floors is the tense reflex that many mammals experience when surprised. When startled, a reflex both humans and cats share is to tense up our muscles. Similarly, both creatures tense their muscles when first entering a free fall, and typically continue to remain tense until the sensation of falling ceases. The sensation of falling, which is caused mostly by acceleration, would significantly decline for a cat after reaching terminal velocity. Reduced tension in the muscles significantly decreases the amount of damage they will sustain upon impact. Because cats that fell from greater heights had more time to overcome the initial shock of falling as well as the feeling of acceleration, these cats could be less injured by impact that those that were still tense when they hit the ground.

Interestingly, both cats and skydivers tend to have a second reflex that they enter after the initial acceleration of free fall is over. Aware of the distance between them and the ground, many intelligent living creatures spread out their appendages and form a sort of parachute with their bodies. Due to their furry nature this is particularly effective in increasing the drag force on the cat, which results in further reducing the speed of its descent. Because it takes cats a few moments to resign themselves to the free fall and assume the parachute position, only the cats that started from high up will have the time to properly respond.

Given this information, we can assume that most of the cats that were dropped after the sixth story hit the ground at roughly the same rate, and that those dropped from even higher maybe have had time to build up drag and receive and even slower impact.



Discussion

Given all this information, I think it can safely be concluded that cats do indeed have a greater chance to survive heights of higher falls than lower ones. Cats that fall from greater heights have more chance to prepare and right themselves, while suffering little by way of increased impact speed. Cats falling from particularly high up have the advantage of increased drag from their parachuting bodies, allowing them an even cleaner landing.

Although the risk of injury is still very high when impacting at terminal velocity, provided that cat lands on its legs most vital body parts should remain intact

It would certainly be helpful if some other veterinary institutions picked up this experiment and added their data to the existing knowledge on cat survival rate. There is already a substantial amount of research into the subject of creating drag for human survival through a free fall, through mediums such as parachutes.

Should you ever find yourself free falling from relatively high up, remember, don't tense out, make a lot of drag, and be sure to land on your feet.

Sources

"Phylogeny and Speciation of Felids," (on cat dimensions and physical characteristics) Mattern, McLennan. (2000)

Georgia Institute of Technology (on the mid-air righting reflex)
helix.gatech.edu/Courses/ME3760/1998Q3/Projects/Nguyen/

Animal Medical Center in Manhattan Falling Cat Study
scribd.com/doc/85/Falling-Cats

and let's be honest, Wikipedia, because everything you'll ever need to know is up there.

