Free Fall & Stretch

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Animation Physics

Falling and Stretching

For comic effect, characters are often stretched when they start to fall.

However, gravity *does not* physically stretch falling objects.

Weightless Free Fall

Weightlessness occurs during falling, even though gravity is present.

NASA has a special airplane for training astronauts in free-fall weightlessness.

The “Vomit Comet” nickname tells you it’s quite a wild roller-coaster ride.

http://commons.wikimedia.org/wiki/File:Astronauts_in_weightlessness.jpg

Riding the “Vomit Comet”

http://www.youtube.com/watch?v=2V9h42yspbo

Skydiving & Free Fall

Skydiving is *not* pure free fall because of air resistance.

The skydiver is not weightless due to this pressure force.

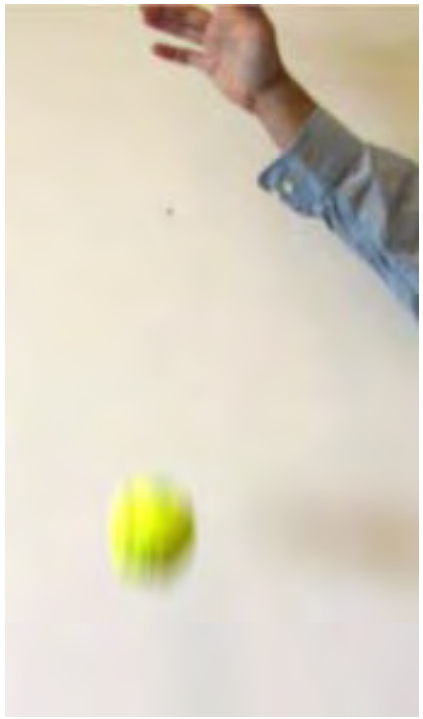
Free Fall in *Madagascar 2*

In parts of the plane crash scene characters are in weightless free fall…

…but not in other parts.

Motion Blur and Stretch

Objects *visually* stretch as they gain speed due to motion blur.

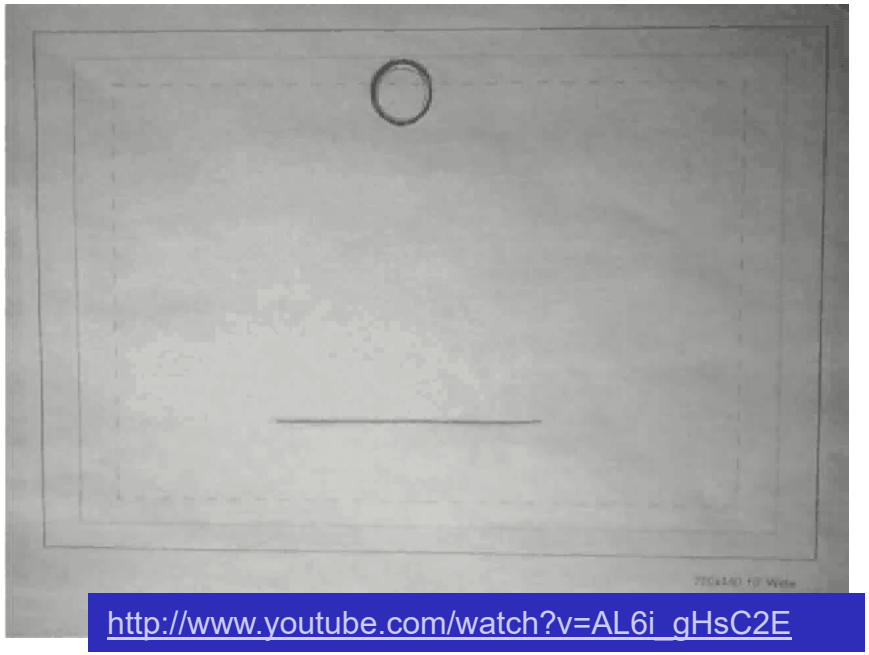


The amount of motion blur in a photograph depends on the speed of the object and on the exposure time.

Motion Perception

Fundamental requirement for realism in animation is *Motion Perception* (also called Beta Movement).

This illusion occurs when a sequence of images is interpreted by the brain as motion.



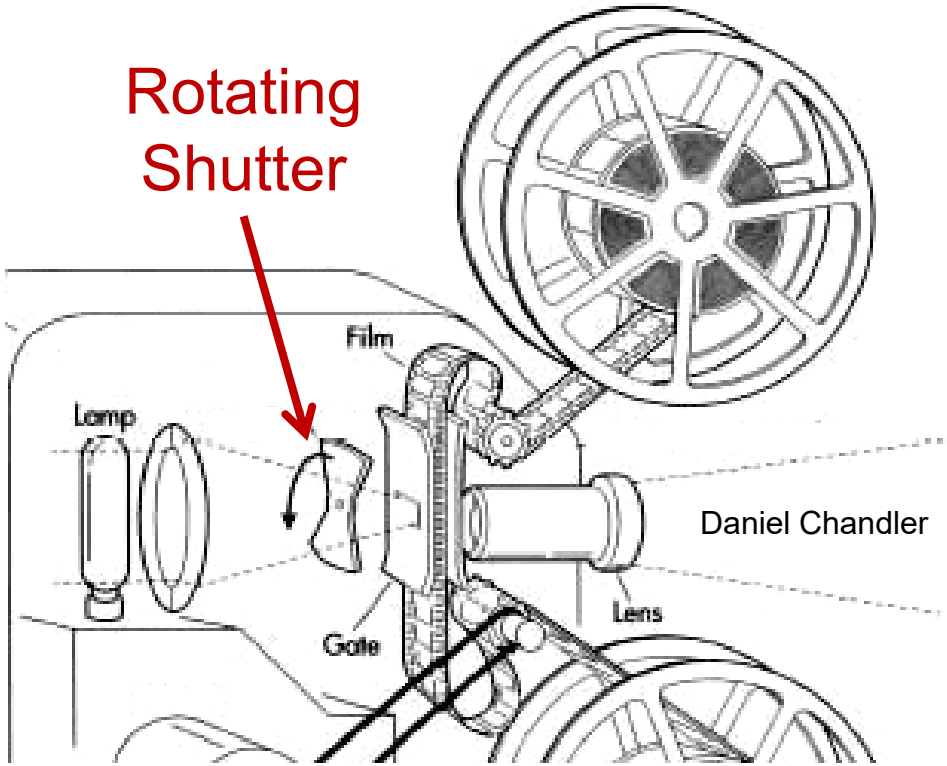
Motion perception occurs for frame rates greater than about 10 frames per second.

Persistence of Vision

Motion perception is often mistakenly identified with *Persistence of Vision* but the two are different.

Traditional film projectors use a rotating shutter, which blocks the lamp when advancing from one frame to the next.

This eliminates motion blur between frames.



Due to persistence of vision we don’t notice the flicker.

Motion Perception & Strobes

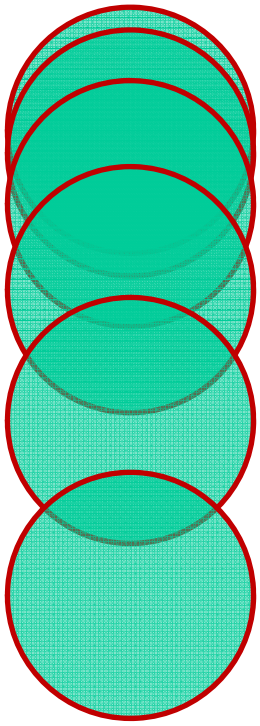
Try moving your arms quickly while a strobe light is flashing.

Motion perception is destroyed if you move fast enough.

You may also see multiple images due to persistence of vision.

Motion Perception & Strobes

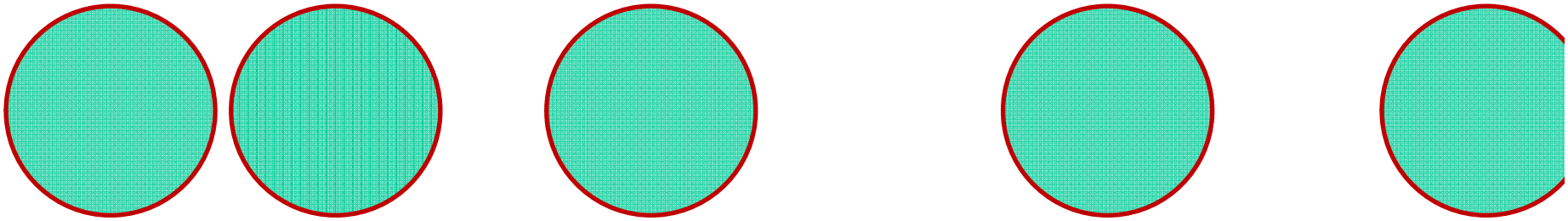
Strobing & Spacings



In animation, when the motion is slow the overlapping of an object from one frame to the next helps maintain motion perception.

When the action is too fast, motion perception can be lost because the object seems to disappear and reappear.

In animation this is known as *strobing.*



Strobing Example

Strobing

http://www.youtube.com/watch?v=QrgtxGQfG9g

The ball seems to appear and disappear around the top and bottom of the bounce.

No Strobing

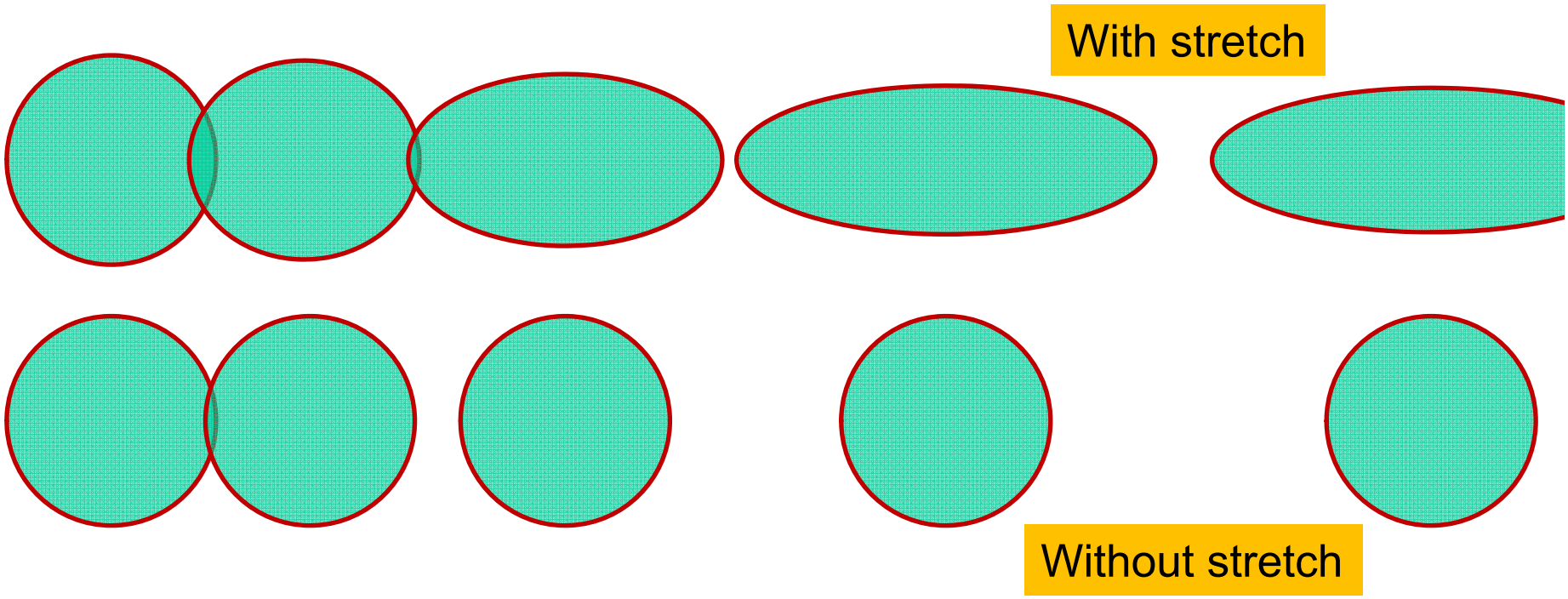
http://www.youtube.com/watch?v=AL6i_gHsC2E

This animation preserves motion perception.

Strobing is more noticeable in your peripheral vision.

Stretch for Strobing

Stretch is used in animation to reducing strobing by minimizing the blank spaces between drawings.



Stretch Animation

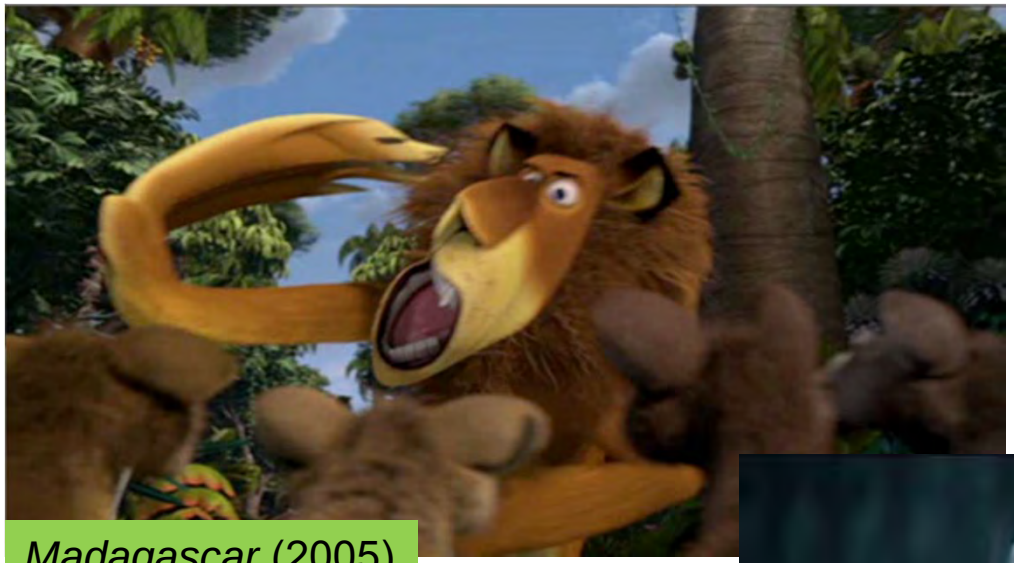
The Dover Boys is a classic cartoon directed by Chuck Jones that has great examples of “stretch” animation (also called “smear” animation).

The Dover Boys (1942)

The Dover Boys (1942)

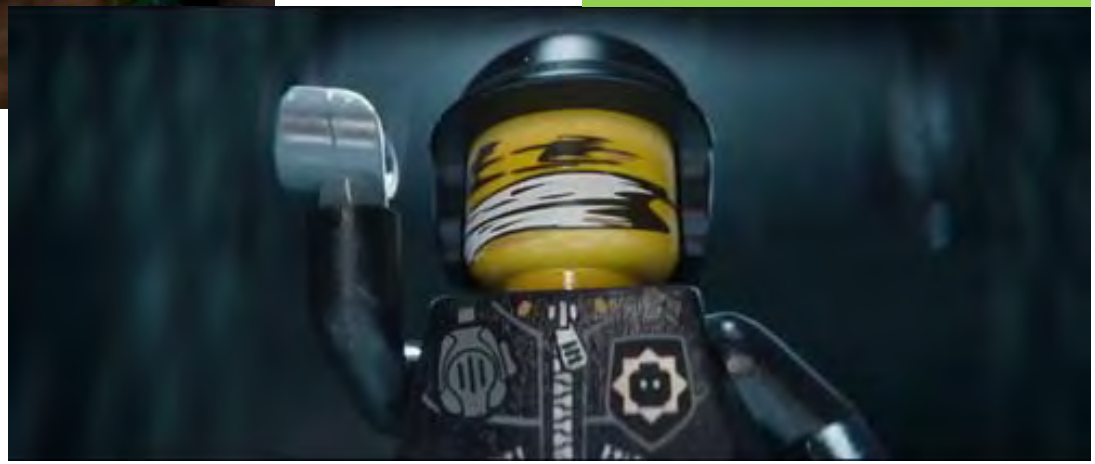
Motion Blur & Stretch

Modern animation uses both motion blur and stretch.



Madagascar (2005)

The LEGO Movie (2014)



ParaNorman (2012)

Stretch in ParaNorman was done with special face plates.

Summary

- The force of gravity does not physically stretch objects as they fall.
- Characters in free fall are “weightless.”
- Fast moving objects visually appear to stretch due to motion blur.
- Strobing is the disruption of motion perception for a sequence of images.
- Motion blur and stretch are used to minimize strobing in animation.