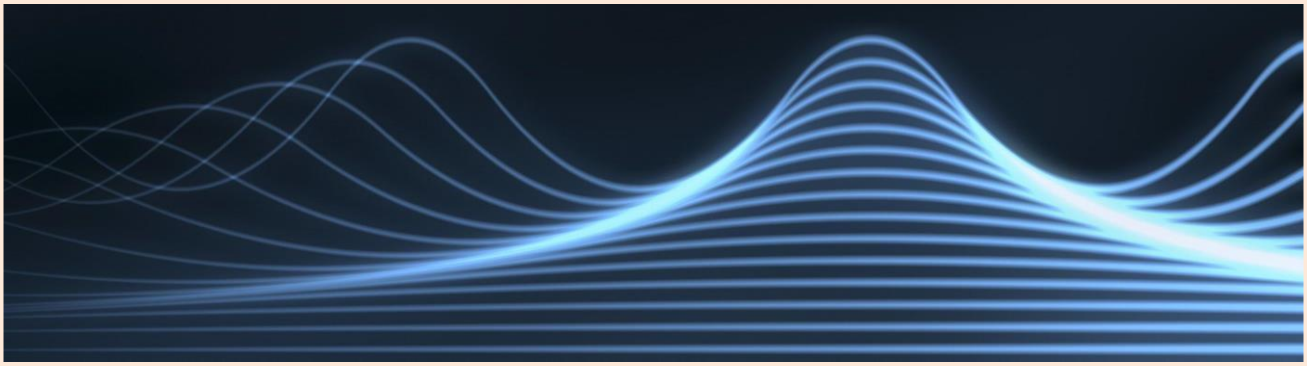
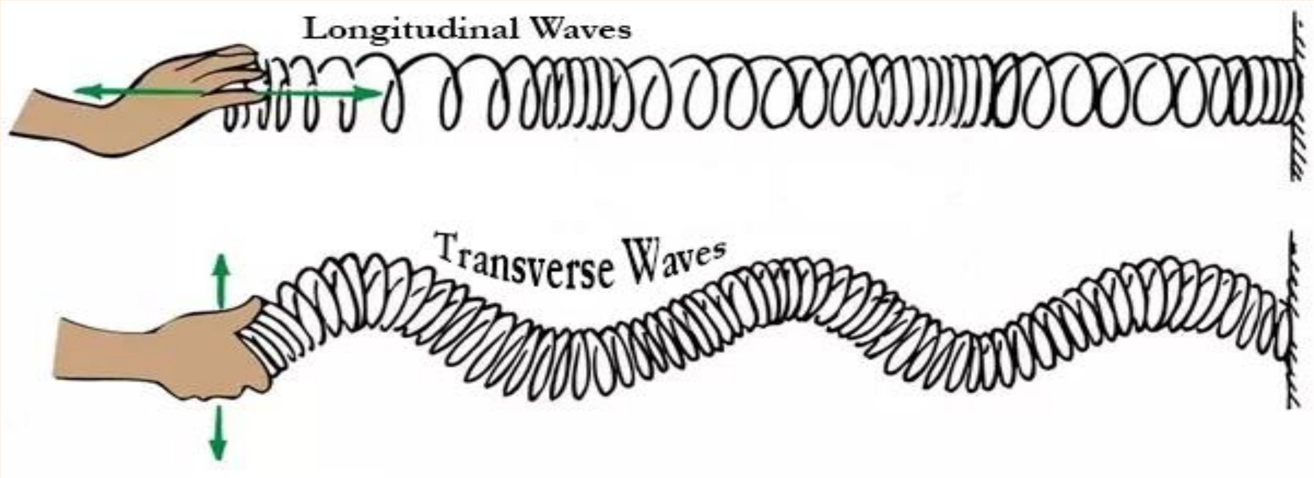
Undulations Painted/Draped on Sidebent Spinal Curves: Transverse, Longitudinal and Torsional Waves



Transverse waves are those we see in a jump rope lying on the ground right after the rope end is abruptly flicked. The wave packet travels like a train on its tracks down the length of the rope. When shaking sheets out onto a bed, we also create transverse waves that move the sheet away from our hands and spread it out more evenly.



Longitudinal waves can be listened to whenever a train leaves the station. The engine car pulls away first, and then each loose car gets pulled in sequence, creating an audible pulse that travels down the entire length of the train.

Torsional waves are sequential twists that travel down the length of our spine or a long flexible object. When we are standing and rapidly turn our head around its vertical axis to one side, we create a torsional wave that descends down the body. The head twists the neck and connecting muscles while sending a wave of torsion (twist) that can be soon felt by the torso as it follows the head. Immediately after this, the same wave can be felt as the pelvis follows the torso in the original direction of twist.

A stiff body does not allow this sequential wave action to occur, rather, the twist will be replaced by a solid rotation of the entire body as it moves as one piece. Although this motion may be desired as an end result of the torso, pelvis, and legs during a pirouette, most ballet dancers spot their eyes by having the head lead the torso and then the torso lead the head. Using torsional waves in between the head and torso, rotational undulations rotate the cranium ahead of the torso's rotation, then stop it at the spot point. After the torso passes, it's energy rotates the cranium once again to pass ahead of the torso onward to the next spot. The viewer is mesmerized by seeing a body in full dynamic motion, yet the dancers face appears held in stillness. Even though the torso and pelvis rotate together, an efficient entry, maintenance, and exit from a pirouette requires a spine that is available for undulation.

Transverse, longitudinal and torsional waves of kinetic energy travel the length of our spine, leading and guiding our extremities. Alternatively, motions of the extremities can distally motor the neck, torso, or pelvis, to create transverse, longitudinal and torsional waves of energy that travel back through the spine.

Flattening or reversing any of the three spinal curves reduces, impedes, or inhibits the ability of the spine to transmit these waves. Vertebrae get stuck at their natural stops and cannot rotate.

Flattening or reversing spinal curves is metaphoric to adding starch to a section of our jump rope, and then trying to pass a wave through a rope that won't take on the shape of the wave.

Sidebending maintains spinal curves which are necessary for healthy wave propagation.

In slow movement, undulations are most visible in the lead and lag of body parts or in the sequence of moving vertebrae. In higher dynamic movement, increased necessary tensions reduce the size (amplitude) of the undulation. The increased tension causes the wave to travel much faster through the body making the wave less visible to an observer. Since the waves travel the same distance up or down the spine as low dynamic undulations, the fast moving high dynamic undulations are visible to the eye for a much shorter period of time. Our common sense of "seeing is believing" leads us to falsely conclude that undulations disappear entirely during high dynamic movement.

Can a guitar string be heard long after our eyes say it is still? This phenomenon is most notable on the thinnest strings held with the highest tension.

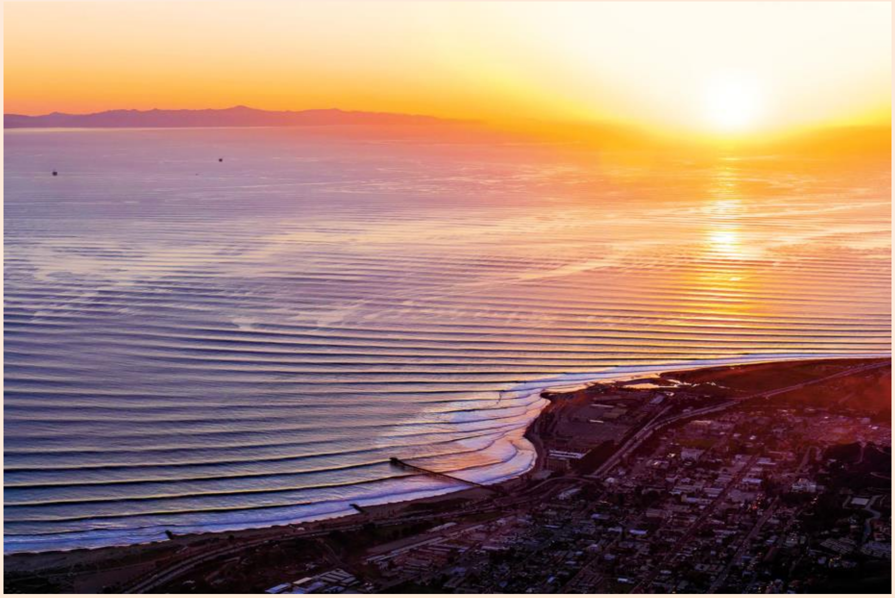
A body that allows undulation can move with high dynamic efficiently, conserving energy by recycling waves in 'body echos' or reflections. Alternatively, undulations can be directed to raise any motor-ic mass or the body in its entirety. This transforms the kinetic energy of motion in the wave into the potential energy stored in a risen body. Increased tension levels in muscle groups surrounding spine create the metaphoric guitar string which can be tuned for fast moving high energy waves with small amplitudes and brief transit times. The paradox is that energy waves become almost invisible to the human eye as the energy of the wave packet increases, while have no waves at all transmits zero energy along the spine.

The perceivable difference is that a no-wave-dancer generates new movement without recycling or being informed by 'old kinetic energy,' while the wave-dancer recycles and directs the previously generated 'old kinetic energy.'

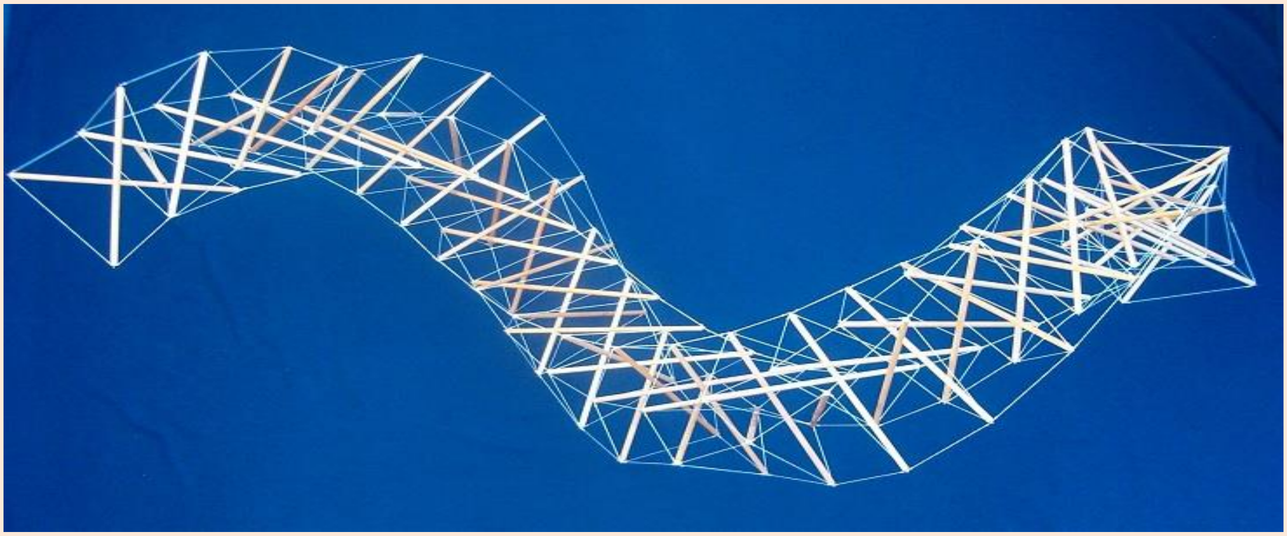
Any part of the body that has risen from harnessing a wave can then fall again. This falling can be used to create new motion in that can be transmitted further to other parts of the body. And so the never ending story of movement continues, until we choose stillness or our energies randomly scatter.

Let us briefly consider the less ideal situation when a body moves dynamically with excess tension in the neck, torso, and abdomen. The body will move more like one giant block, without any springiness. This type of movement will require the legs and arms to push every time the body rises, and push every time the body falls, as momentum and energy are inefficiently conserved.

This is a body whose undulations have disappeared. This is a dancer who is working too hard.



Water is incredibly sticky to itself, and it's this stickiness that can hold tension, like the fibers in a rope do when pulled tight. Waves travel on the sea because water can hold in this way a very large amount of surface tension. This explains how a breaking wave curls over and pulls water from behind itself, it simply cannot let go. Even after the wave breaks and mixes with air, the water holds on to itself in the form of foam and droplets. To get water to let go, one must first add enough energy to bring it to a boil.



Each vertebrae holds onto its neighbor tightly via a variety of connective tissue. Unlike water, the tensegrity design of the spinal column maintains its structure while at the same time providing a river for waves to travel upon. The ligaments, tendons, and muscles simply cannot let go as the packets of tension get transmitted from neighbor to neighbor.

Highly energetic transverse waves that travel on the ocean, known as a tsunamis, can contain energy far exceeding any wave caused by even the greatest of hurricanes. Tsunamis travel the ocean at approximately 600 miles per hour (970 km per hour) which is the same speed as airliners.   When they pass large ships or small craft on the open ocean, there is typically a six inch (15 cm) rise in the water level that is spread out over many kilometers. People on board often don't know that a powerful wave has just passed. Only when the wave reaches shallow water does the land direct all the kinetic energy into a tall rising of the water just offshore. When the water can no longer support itself, it falls forward and spills out onto the land as a river of ocean water. All the movement and aftermath of a tsunami comes from a barely visible high speed wave. A similar phenomenon occurs in and around our spine.

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