No 1 GRAVITY and ANTIGRAVITY

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1. Today, I thought it would be interesting to look at gravity and how it affects everything we do.
2. We will also have a look at how we sometimes talk about gravity in the Alexander Technique. You hear people talking about *"lengthening against gravity"*[1] and you may have wondered in what way this is different from the ordinary lengthening which we are always encouraging.
3. You also hear people talking about *"the anti-gravity muscles"* which can sometimes sound rather mysterious and Dr Who-ish. What do we actually mean when we talk about them?
4. So we start with gravity. It is a quite a complex subject which could take us into discussions on Einstein but these are far above my salary-grade in the CTC. So I will stick with Sir Isaac Newton and keep it simple.
5. In the world of Newton, everything on the earth is being pulled downwards. More precisely, everything is being pulled towards the centre of the earth. Apples fall downward from trees as Newton is reputed to have noted.
6. We describe the fact that everything is under this downward pull by saying that we live in the gravitational field of the earth. It is from being in this gravitational field that the whole concept of weight or heaviness comes.
7. If I hang this piece of metal from my finger I experience a downward pull on the finger. Gravity is pulling the piece of metal towards the centre of the earth and because my finger is resisting it, I feel the pull on it.
8. If I put the piece of metal on top of my hand it is still attracted towards the centre of the earth. I experience it as a weight or force which is pushing my hand down.
9. In fact, we define the weight of a thing as the downward force it exerts as result of the pull of gravity to which it is subjected.
10. We can measure this with a spring balance or, more usually, with a weighing scales. When you stand on the weighing scales, the reading on the dial is the downward force gravity is exerting on you and which you in turn are exerting on the scales.

[1] For example, Dimon (1999)p54

11. But gravity is not just acting on things we think of as weights. It is also acting on us. When I am holding the piece of metal and gravity is pulling it down, it is also pulling down my hand and arm. I can experience this by sticking out my hand and arm. Even without any weight to support, I can feel they are pulled downward by gravity.

12. If I want to keep my arm sticking out, I have to resist the pull of gravity by tightening the muscles in my arm and shoulder. And of course, they have to use energy to it. This is why they begin to feel tired after a while, not because they are doing anything but just because my arm is in a particular position in the earth's gravitational field.

13. If I stop tightening the arm muscles, gravity is still pulling the arm downwards and it falls down by my side. Now the muscles are not doing so much and it is the tendons and ligaments in my shoulder are resisting the downward pull or the weight of my arm.

14. This why we ask pupils to rest their hands on their thighs when they are sitting on the chair. Instead of the weight being taken by the shoulders, it is safely propped up by the lower leg which is resting on the floor, and the leg and foot bones are now doing most of the carrying.

15. This reduces the pulls and tensions in the neck, shoulder and chest areas and makes it easier for us as teachers to work on them. It is another example of what Alexander called a *"position of mechanical advantage"* which as he said *"gives the teacher the opportunity to bring about quickly with his own hands a co-ordinated condition in the subject."*[2]

16. Just as an aside, because it sometimes comes up in this kind of discussion, I may as well mention the distinction between mass and weight which is made by people who feel a need to be precise. If you look at TDM Roberts' book, *Understanding balance* you will see he considers it as a matter of great importance.

17. In broad terms, the weight of a thing is the downward force it exerts on whatever is supporting it. So if I take a standard bag of sugar and put it on a scale, the reading will be 1 kg. That is the force that gravity exerts on it here on earth.

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[2] Alexander (1910)p118

18. But the force of gravity is not the same wherever you are. It is much less on the moon, for example.

19. So if you are giving AT lessons on the moon, you will need to be very careful when taking the head because it weighs a sixth of what it does here. If you apply the amount of force you would use here, for example to lift the head to slip another book under it, you could very easily dislocate the person's neck.

20. But for most of us earthbound creatures, we don't need to worry. The weight of a thing, the downward force it exerts on whatever is supporting it, is pretty constant no matter where you are on the surface of the earth.

21. The mass of a thing, as distinct from its weight, is the amount of stuff in it and this does not depend on where it is. If I take the same bag of sugar to the moon its mass will remain exactly the same.

22. This means that if you want to be really precise about your diet and its results, instead of talking about losing weight, you should really talk of losing mass. If you do, people will know that you know your physics.

23. I now want to look at some of the implications of spending our lives in the earth's gravitational field. The fact that we have evolved as a species within it, obviously means we are biologically adapted to it.

24. This means that it affects the way every bit of us works as astronauts discover when they are without it the space station. When people spend times in the space station, their bones tend to lose a significant amount of mass. They also experience increased difficulty in swallowing because there is no gravity to help things on their way.

25. But for our present purposes, I just want to look the system of bones, muscles and tendons we call the musculo-skeletal system. This is what gives us our shape. If we did not have a musculo-skeletal system, we would have no way of moving ourselves about or doing things. We would simply be fairly formless blobs, like jelly fish.

26. The musculo-skeletal system is what enables us to do all sorts of things that jelly fish cannot, like standing up, sitting down and moving around, as well as more exotic things like skiing, singing and using computers.

27. The engines or motors which enable us to do all these things are the muscles. There are lots of these all round the body and they come in various kinds.

28. We have those that work the intestines, the bladder and so on. For the most part these work away automatically and unconsciously and we have very little, if any, direct control over most of them. The same applies to the particular type of muscle, called the cardiac muscle, which drives the heart. This also works automatically.

29. The muscles we are interested in today are called the skeletal muscles. They are called this because they attach to the bones of the skeleton and there are about 600 of them in the body. They are subject to voluntary control which is why they are often referred to as the voluntary muscles though a lot of the time they work automatically.

30. There are in fact three modes of functioning for the skeletal muscles.

31. The first is when they are acting under conscious control doing what we want them to do. The second is when they are working automatically or reflexly in accordance with the innate programs we have as human beings just as all animals do.

32. The third is when they are working unconsciously in accordance with habits we have acquired. This is the area where we get into what Alexander called faulty sensory awareness. We will have more to say about all of these.

33. But for now it is back to physiology. The skeletal muscles come in a variety of shapes and sizes which you can see if you look at an anatomical chart. There are big flat sheets like the latissimus dorsi which wraps around the back and attaches into the upper arm. There is the big wodge of the gluteus maximus in the bottom.

34. We have the one we all learn about early on in the upper arm which is called the biceps brachii. The smallest one of all is just a millimetre long. It is called the stapedius and is in the inner ear. It is part of the system which protects the ear against excessive noise.

35. The basic characteristics of all these muscles whatever their shape or size is that they have a central operational part, called the belly, and tendons which attach to bones in the skeletal system.

36. In diagrammatic form, this is how they look. Here is the belly, and here are the tendons which attach to the bones. When a muscle is activated the belly contracts and the tendons pull on the bones to which they are attached.

37. It is hard to believe that everything we do, all the lifting, walking, playing the piano is the result of just these muscle contractions. But as we saw when we were looking at levers, this is all that the muscles do.

38. They contract or tighten, and they release or relax. They do this tightening in one of two ways. It is either *isotonic* or *isometric*. These can be thought of as doing or resisting.

39. In an isotonic contraction the muscle shortens and the two points to which it is attached are drawn closer together. We typically see this when I contract the biceps and lift the arm.

40. In the isometric contraction, the muscle length remains the same and it resists the force upon it. We have an example in which I hold the arm in a fixed position while someone adds a weight to it.

41. Those are the basic bits we need for getting into our discussion about how the body goes about moving itself and doing things in the gravitational in which it finds itself.

42. I am going to start by looking at how we stand and walk. There is a rumour that human beings have not learned how to do it properly, that we have not fully evolved into walking on two legs otherwise called bipedalism. This idea comes from paleo-anthropologists who were studying the evolution of pre-human species.

43. There is a paper written by Philip Tobias, the man who succeeded Raymond Dart in Witwatersrand University. It is called *Man the tottering biped* and he gave it at a conference in Australia in 1992 and I think it has quite a bit to do with the belief that we are not comfortable when we are standing and walking on our hind legs.

44. In this paper, Tobias quotes from an earlier paleo-anthropologist called Napier who said in a paper written in 1952 that:

> *Human walking is a unique activity during which the body, step by step, teeters on the edge of catastrophe.*[3]

[3] Tobias (1992)p15

45. This is obviously absurd. Just because we are more easy to push over than a cow or an elephant, does not mean that we have not properly adapted to our upright stance.

46. As Nikolaas Tinbergen pointed out in his Nobel Prize lecture, humans and their immediate hominid predecessors have been doing it for about five million years. We have had lots of practice and have fully adapted to it.

47. Our bipedalism is at the heart of our versatility and flexibility as a species. That is a discussion which takes us into interesting territory but that is for another day.

48. For now, we want to start looking at how we go about doing our standing. We it in a gravitational field which is pulling us down all the time. We are not teetering on the edge of catastrophe because we are not adapted to our gravitational environment.

49. If we are in trouble with our standing and walking it is because we have used our control over our voluntary musculature to subvert our evolutionary inheritance.

50. Alexander's achievement was to realise that we have used our freedom of action to train ourselves so deeply in misuse that we are no longer aware of that misuse or how to get out of it.

51. That's all for now. Next time we will continue with the topic of muscles and gravity.

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