

No 38 Muscles and exercise

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CTC

30 June 2015

1. Today, I am going to talk about muscles and exercise once again. We looked at this a couple of months ago but I think it is a big issue and it comes up again and again when you are an AT teacher.
2. These days there is so much stuff being pushed at people in the way of commercially promoted exercise and fitness programmes, some of which are completely misconceived, that it is important to be able to offer some sensible advice to your pupils.
3. So this is some easy revision and a chance to ask any questions you want before you head off on the summer break. Remember just one thing, there is no question too stupid to ask. You may very well be doing your wise-looking friends a favour by asking it.
4. The first point is that because we keep talking about the importance of non-doing, some AT people have a slightly uneasy feeling about exercise as though we are against it. This is totally wrong.
5. Unused muscles waste away as anyone who has a plaster cast knows. A reasonable amount of vigorous exercise is essential to a healthy human body. That does not mean that beating yourself up in the gym or running yourself into a state of exhaustion three times a week is a good idea.
6. So it is good to have a grasp of the basic issues and be confident enough to give your pupils sensible advice.
7. First a bit of quick revision of muscle science. The muscles we are concerned with today are called the skeletal muscles because they are attached at one or both ends to a bone in the skeleton. There are about 600 of them so we can only expect to know the names of a limited number of them. So don't worry if after colouring them in you can't remember what they are.
8. They are also referred to as the voluntary muscles because to a greater or less extent they can be deliberately mobilised into action. I can tighten my stomach or jaw muscles consciously. But most of the time they are working away automatically or reflexly and we have no conscious awareness of them.
9. Each muscle is made of hundreds, up to many thousands, of muscle fibres. The fibres come in little bundles of between ten

and hundreds of fibres called fascicles which act together in the muscle.

10. The only thing a muscle does is shorten or tighten and it is the muscle fibres that do this. When this happens the muscle is doing work and it needs energy or fuel.
11. The immediate energy source used by muscles is a substance called adenosinetriphosphate (ATP) which is made inside the muscle fibres themselves. For this they need oxygen and they need to be able to get rid of the waste products produced when they make and use the ATP.
12. The job of supplying the oxygen and getting rid of the waste products is done by the body's blood supply. This is carried round the body by the networks of veins and arteries. These are basically tubes but they often referred to as blood vessels which used to puzzle me. The overall arrangement is usually called the vascular system.
13. The muscle fibres are conventionally divided into two broad types: red and white but because life is not always as simple as we would like, there are various in-between types.
14. In red fibres, the colour comes from myoglobin, a red-coloured substance in the blood which picks up oxygen in the lungs. The red fibres get their oxygen from the blood on a continuing basis and are able to keep working as long as the blood supplies the oxygen they need and takes away the waste products.
15. Because of their continuous dependence on the oxygen-renewing activity of the lungs, these fibres are sometimes referred to as aerobic. They are also called slow or sometimes slow-twitch fibres because they are relatively slow to respond to signals from the brain.
16. The white fibres, instead of making their ATP as they need it, accumulate stores of a substance called glycogen when they are resting and they are able to transform this into ATP quite quickly when they are called into action. When they are in action, they produce lactic acid which causes the muscles to ache.
17. The white fibres are often called fast or fast-twitch fibres because of their relatively fast response to a signal from the brain.
18. They typically come into use when we do something that requires a fast response such as a sudden awareness of

danger. The response does not have to be particularly violent. If I want to brush away an insect from my eye, it requires a rapid but delicate movement and this will mobilise white fibres.

19. Because they are relying on the stores of glycogen to produce their ATP, the white fibres can only keep going as long as the glycogen store lasts. One of the waste products produced by muscles as they use up their glycogen is lactic acid which causes the muscles to ache.
20. In a normal person, the glycogen only lasts for about 20 seconds. If you are carrying a heavy suitcase, you find that after quite a short time, your muscles begin to hurt and you have to put the bag down.
21. What is happening is that you have used up the immediately available glycogen and there has been a build-up of lactic acid in your muscles. You need a rest to rebuild your glycogen store and allow the blood circulation to carry away the lactic acid.
22. If you happen to be a trained athlete, your white fibre muscles may be able to keep going for 30-40 seconds before your muscles give up on you.
23. What all this means is that red muscle fibres predominate in endurance activities like standing, sitting, maintaining a good posture, and long-distance running. White fibre muscles are adapted for quick bursts of activity.
24. This shows up in the distribution of red and white fibres between various vertebrate animals.
25. Cattle, for example, which are noted for taking it easy rather than gambolling about their fields, have mainly red fibres in their muscles. That is why their meat is red. Birds on the other hand are known for flying busily about the place, and tend to have a preponderance of white fibres which shows in their white flesh.
26. There are also big differences in the way the two types of muscle fibres respond to exercise. We often think of exercise causing muscles to bulk up but in the case of red fibre muscles, the opposite can happen.
27. This is what one authority says:
...endurance training results in muscles that are not only more effective during sustained activity, but also in the case of long-distance runners, more slender. The explanation for the smaller girth is that the myofibrils, and the fibres themselves, are reduced in cross-

sectional area. It is likely that this adaptation allows better diffusion of metabolites and nutrients between contractile filaments and the cytoplasm, and between the cytoplasm and the interstitial fluid.¹

28. This why typical long-distance runners, like the Kenyans and Ethiopians, tends to be quite slightly built.
29. Exactly the opposite happens with exercise that brings the white fibres into action. The muscles get bigger because the fibres in them increase in size to store more glycogen.
30. This is why the top sprint runners like Usain Bolt are hugely muscled. The 100 and 200 m sprint racers depend entirely on the glycogen stored in their muscles.
31. There is another important aspect of developing the white muscles that is called *The specificity of exercise principle*.² It is also known as the SAID principle that stands for the *Specific Adaptation to Imposed Demands*. Basically, this means that people get better at the particular exercise they are carrying out but the effect on other activities is small.
32. Sports scientists say that the greatest changes that take place in people who exercise their white muscle fibres in specific muscle-building exercises is in their ability to do the task they are practising.
33. Basically doing exercises in the gym makes you good at doing exercises in the gym. Or if you are an athlete, your training makes you better at jumping or running or whatever.
34. The other thing is that the gains in strength can be quite short-lived. Once a person stops a particular training routine, the effects wear off at about the same rate as they occurred during training.³
35. Most of the people you will be dealing with as an AT teacher will not be training for sporting events. The mums' or dads' egg and spoon race is more likely than the 100 metre Olympic hurdles. But nevertheless many of them will also be doing things like running, jogging, going to the gym in the belief that this is going to keep them fit and healthy.
36. So when we are advising them as pupils we need to know something about the relationship between exercise and health.

¹ McComas (1996) pp304

² Kamen (2001)p72

³ Ibid.p47

37. According to a book called *Foundations of exercise science*:
*...very easy exercise (low intensity and short duration) can make the biggest improvements in the health benefits of exercise...the benefits plateau at 50% intensity and 30 minutes duration. Exercise of greater intensity or longer duration provides little additional benefits to general health.*⁴
38. This is good news for most of us. A brisk walk or the sort of activities involved in organising a family – or an AT school – is enough to look after our general health and physical well-being.
39. But but but ...say the people who believe in their gym workouts and their jogging. They enjoy doing them and they feel better after them. As AT people, we need to understand what is going on if we are to talk sensibly to these people who may come to us with neck, shoulder and lower back problems.
40. This takes us back to the red and white fibres. In humans most muscles are a mixture of different types of fibres. But there are significant differences between muscles, depending on their function. Muscles that are important to posture, such as those in the neck, back and legs have a higher proportion of red fibres. The soleus in the calf has about 80 percent red fibres.
41. Other muscles with a preponderance of red fibres are the multifidus which runs down the whole spine, tying together the vertebrae. So also is the front abdominal muscle, transversus abdominis.
42. In muscles that are used for intermittent activities like lifting and throwing, the proportion of red fibres is lower. In the biceps brachii, for example, the proportion of red fibres is about 40%.
43. Given that we need to exercise both red and white fibre muscles, how does the body decide the order in which to bring the red and white fibres into action in the different muscles when we decide to do something. This is called the order of recruitment.
44. Basically the body takes a conservative view and when possible it uses the red fibres first. We can see this makes sense in evolutionary terms.

⁴ Ibid.p73

45. If we are strolling about in the savannah without any feeling of being threatened, we may as well keep our stores of glycogen available for immediate use in case a lion comes leaping out of the bushes at us. In modern life, the equivalent would be a mad cyclist on the pavement.
46. So suppose I am an office worker and I do not know any of this stuff. I have had a horrible day. I cannot wait to get to the gym to work it off. This is a time when I can do myself serious muscle damage.
47. Because I am tense, I am ready for immediate action. I have been twisting my neck about because it feels stiff which means I have the white fibre muscles in my shoulders already recruited. I may also believe in the dreadful saying: “no pain no gain”. When I get into the gym, I hurl myself into the various machines and work up a sweat.
48. One of the effects of this intense activity is to release endorphins – opium like substances – into the bloodstream that dull our sense of pain and make us feel a bit happier. We feel pretty good about what is going on and we do not notice the pain.
49. So my session in the gym damages my neck and shoulder muscles, which I do not notice because of the endorphins. It also ignores the exercise needs of my red fibre muscles.
50. This explains why you sometimes come across pupils, usually men, who have been regularly exercising in the gym to keep themselves fit, but have horrible neck, shoulder and lower back problems. We also find that though they have impressively bulky chest and shoulder muscles, they cannot sit upright in a chair for more than a couple of minutes.
51. What has happened is that they have damaged themselves by over-exertion – anaesthetising their muscles with endorphins before over-using them, which is where the aches and pains come from – as well bulking up their white fibre muscles but neglected their lumbar area postural muscles.
52. You will also tend to find that they have “ergonomically designed” office chairs and car seats with lower back supports that prevent them using their lumbar muscles. So they do not have the strength in their lower backs to sit upright.
53. So where does this leave us as AT teachers trying to have a sensible discussion with such a pupil about exercise?

54. The first thing we talk to them about is why they are and the price they are prepared to pay for it.
55. If you want to be a prima ballerina or a top class athlete in most sports, you have to pay a heavy price for it in dedication and usually in general health. Look at the number of injuries most athletes suffer.
56. We have a niece who was hoping to make it into the Irish Olympic rowing team but the price she has paid in injuries, general health and time is huge – and she has not made the qualifying performance.
57. We can help such people reduce the price they have to pay to as they struggle to achieve their exercise goals.
58. Strangely enough, the advice we have for them is no different from that we give our pupils who not aim at athletic fame or fortune, and are prepared to settle for the health benefits of a programme of moderate exercise.
59. We tell them and show them how to stand quietly, looking for their length and balance, widening, freeing the neck, letting the breathing settle. If they feel they want to over-develop their pectorals, we say exactly the same, telling them to begin quietly, gradually getting into their warm-up routine, keeping themselves free and released particularly in the head-neck area.
60. If they are determined to over-exercise, you will at least have ensured that they are starting with the best possible muscle configuration and given them a chance to reduce the damage they are about to inflict on themselves.

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