Resistance training as a Newtonian 4D model

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To understand exercise mechanics and therefore further understand resistance training science, we need a fundamental shift in the way we see training. Without removing EMG and long term studies, simply adding different technologies to increase our ability to predict changes in outcome, based on changes in exercise mechanics and training programming would definitely help us adding rigor to training studies.

To do so, a deep understanding of the physics of exercise is needed. With that knowledge, creating new technologies to help humans with their bias make data more accurate would be possible. For instance, a subtle change in the angle between the force arrow of the barbell and the targeted muscle can radically change the efficacy of the particular exercise.

Four dimensions

The first dimension is the arrow (with its direction) of the force that acts on the weight or machine. This concept explains why a bench press mainly targets the pectoralis muscle, while the exact same set-up, but with a cable pulling in the other direction (ie. cable row) targets the back musculature. The second dimension, like reported earlier, is the angle between the targeted muscle and the force arrow. Changes in that dimension changes (a) which muscle is being targeted. A small change in the angle between the humerus and the body can potentially change if the rear deltoid, the upper trapezius or the lat is the primary working muscle. (b) In the same manner, it can change the part of the muscle that is being targeted the most, for example the clavicular or costal part of the pectoralis major. Finally, (c) it can change the efficacy of an exercise, by decreasing the force that should act on that muscle, and placing some of it on joints or other muscles. If someone is doing DB biceps curl with 10kg, but there is a 20° angle between the humerus and a straight line (force vector) perpendicular to the floor, the force being applied in a direction that increases the probability that the nervous system will favor the desired muscle in contracting is ~40 N (10 * 9.8 * cos(20)) compared with 98 N if the humerus would have been perpendicular to the floor.* We can see this having an effect in a study on different ranges of motion, potentially due to a lack of mobility.† The third and fourth dimensions are what is called the resistance profile. Basically, it is the power of an exercise (torque * angular velocity) at every angle.‡ The second part of the time dimension is the time spent in certain parts of the movement. Doing an isometric

contraction at the end of the biceps curl will not change the resistance profile of the exercise, but it can change the outcome in terms of stimulus.

* *N.B. This is a simplification since we were still in 2D.*

† *For further reading, click here.*

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The role of technology

Technology could *easily* be used to monitor changes in exercise mechanics, using data from videos or other instruments. It would be extremely useful to assess the difference between individuals and the way a movement is performed. It could help scientists by providing more rigorous and accurate data. Also, it could potentially help thousands of individuals in the practice of safe, thought through training regiment — if the technology is cheap and easy to use.