The Functional Continuum

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INTRODUCTION

The *Functional Continuum* explores how functional an exercise is by determining the amount of movement required to complete the action. As all sports and most activities in life (functional) require multiple joint movements, the more functional an exercise, the more transferable it is to sport and everyday life. Furthermore, the functional continuum also allows exercise prescriptors to understand whether the exercise selected has a high movement focus or a high muscle focus and explains how to increase or decrease this focus. With this in mind however, often, true functional application, may require counter-functional training to compensate for the continual functional application of the musculo-skeletal system (as will be discussed).

Role of Skeletal Muscle

Before we move into discussing the functional continuum, here are a few reminders as to the role of skeletal muscle.

Voluntary movement; locomotion; manipulation of the environment; facial expression. Voluntary control. (Marieb 1998)

....skeletal muscle is responsible for activities such as walking and manipulating objects in the external environment. (Spence 1990)

Through contractions, muscles perform three important functions: Motion, Maintenance of posture and heat production. (Tortora & Anagnostakos 1987)

Note: None of these references have the function of skeletal muscle as either hypertrophy or aesthetics. All of them do however mention its importance in movement and motion.

During the analysis of an action or exercise the joints involved and their movements are identified. It is the number of joints employed and the number of planes across which the force is development that determines the movement classification.

Isolation

Isolation movements involve actions that cover only one joint.

Compound

A Compound movement involves actions that take place over more than one joint.

Kinetic Link

- Complex

A complex movement is one in which more than one compound movement is linked together to complete an action.

- Multiplane

Multiplane exercises are those that would involve movement across more than one plane, Eg. plyometrics. Not only are plyometric activities complex but they also have movement across more than one plane, hence allowing greater sports specificity.

PLOTTING

The more motion involved in the action the greater the number of joints required to perform the action. With this in mind, and other factors withstanding, the generic plotting of the functional continuum would be as shown below.

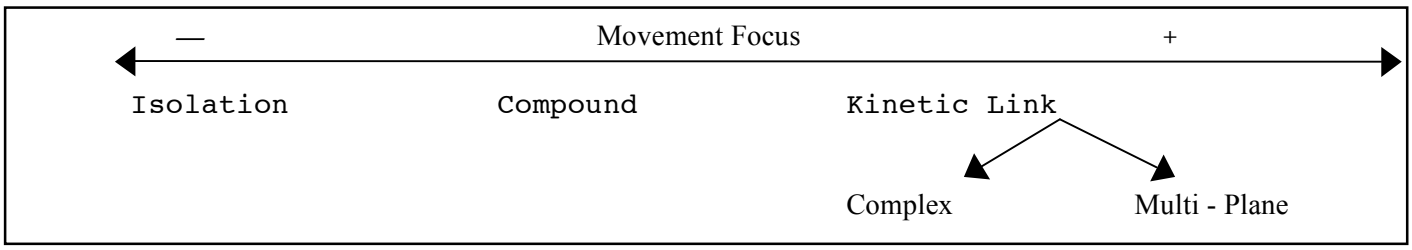

Figure 1. The generic plotting of the functional continuum.

INCREASING THE MOVEMENT VALUE

Stabilisation

Activities that require the body to stabilise other body parts through increased synergy, increase the functional value of an exercises, two qualities vital to sports performance and everyday function.

- *Dumbbell Exercises* — Dumbbells due their independent nature have a higher synergy requirement than bar or fixed machine work. They also allow greater versatility in movement and mimicking of specific actions.
- *Fitball / Duradisc Exercises* — Fitballs / Duradiscs decreases the stability of the body by amplifying weaknesses in balance. Therefore exercising on a fitballs / duradiscs increases the need for effective stabilisation, hence increasing synergy between muscles and core stabilisers.

Potential For Movement

The greatest potential for movement is one that allows full range of motion (ROM) across all planes of movement in unilateral independence. Dumbbells for example, allow greater movement (hence require greater stabilisation) than a barbell. Medicine balls, with their droppable - throwable nature, can provide even greater potential for movement than a dumbbell.

Consider the application of power to a boxing punch or throwing an implement. When utilising a dumbbell, force is developed and momentum is created, similar to the desired power action. However, towards the end of the action a breaking force must be applied to protect the musculo-skeletal system from damage and prevent the dumbbell from flying across the room. So in fact this power training is actually anti power training. A more effective application would be the ability to release the resistance allowing force to develop up until the point of impact / release.

RE-PLOTTING

So as can be understood, plotting on the functional continuum is not quite so black and white. For example; a Squat performed on a Universal machine (a fixed - machine) would have a lower synergy and stabilisation requirement than a squat performed on a smith machine, which would in turn have a lower synergy and stabilisation requirement than a barbell free squat. Although all these are compound exercises, they have a different plotting on the continuum. As shown in Figure 2, the continuum is more complex than it first appears.

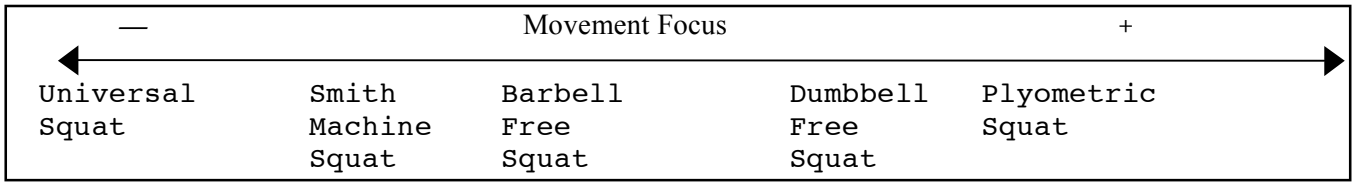

Figure 2. Plotting a compound movement classification accounting for the increased stabilisation requirements and potential for movement.

COMPARING THE FUNCTIONAL VALUES

Isolation vs Compound

> *The technology of the fitness boom with its muscle isolating machines and focus on parts of the body produces the body as an object of increasingly isolated and fragmented parts.* (Costa 1995).

One must ask how functional isolated exercises are. Not only is the cross over to function of single joint exercise poor (Chek 1998a) but when in life are isolated movements performed ? Name any sport that utilises a purely isolated action? When in life does the knee perform extension alone, as in the Leg Extension, whilst the back and upper thighs are supported?

There are few benefits of an isolated action for the general fitness trainer or even advanced athletes. Some of the common reasons (or excuses) given by resistance training (RT) instructors for the implementation of isolated exercises include:

◆ *Pre-fatiguing and the Weakest Link:*

The means of isolating a muscle to ensure it is the limiting factor in an exercise, is utilised by body builders to target a specific muscle requiring growth. However this value is almost purely aesthetic and of limited use for athletes. For example, if an Olympic lifter always fatigues in the glutes when dead lifting, what good would pre - fatiguing the quadriceps be (to ensure the quads are the limiting factor in his / her dead lift) to performance.

♦ *Synergy:*

The importance of synergy, the working together of muscles, cannot be overemphasised. When isolating a muscle, you are effectively breaking down the communication systems between that muscle and others. The effect of this is a break in intermuscle communication and the decreased ability of the body to work as a single effective unit. ***Just because you know the letters of the alphabet – it doesn't mean you can read***.

Furthermore, with many articulations in the body being bi-articulate, when employed in movement they move through passive and active insufficiencies (Steele, 1991) and require 'concurrent shifts' in order to complete actions. By training a muscle in isolation these required roles cannot be facilitated and therefore inappropriate motor patterns may be developed.

♦ *Segmentational Force Velocity:*

When developing force, the body acts like a relay team; as the current sprinter moves to the exchange area, the following runner begins to accelerate to 'transfer the speed of the baton'. Following this train of thought, the body learns to begin accelerating whilst the preceding segment nears the end of its involvement (usually the more proximal and / or larger segment). Again consider the boxing punch, velocity is generated from the hips through the torso, thorax, shoulder, and finally the elbow, culminating in impact. If only speed at the elbow is developed through an exercise like an elbow extension, the ability to transfer force is negatively influenced (Elliott, 1991).

♦ *Rehabilitation :*

Even though an isolated exercise may be prescribed by a physiotherapist, (Eg. The Leg Extension, prescribed to strengthen the Vastus Medialis Obliques or rotator cuff work), it is done so in conjunction with functional movement and mobility work. You will find that for most physiotherapists, it is the return to function that is of primary concern and the restrengthening exercises are so directed. Therefore, although isolation exercises may be utilised initially to restrengthen a muscle, the muscle's actions will then be integrated back into its functional application Eg. The VMO restrengthened through the Leg Extension to prevent a tracking concern, is then employed back into a compound / complex action where it is required to perform its role in its true application.

♦ *Muscle Balance :*

Would not a compound exercise provide the same muscle strengthening benefits whilst providing a greater functional movement and co-ordination aspect. For unilateral actions like Javelin throwing or bowling, where one side is trained more than the other, the same gross action can be performed on the weaker side utilising weighted balls like medicine balls.

<u>Machine vs Free Weights</u>

80% of injuries in the US are from machines like a Pec Deck. (Chek 1998a).

♦ *Synergy :*

For many years it has been commonly advised that beginners utilise machine weights rather than free weights. The predominant reason being safety, as less synergy and balance is required. However what happens in real life when the client is required to utilise the muscles in a functional capacity, a capacity which requires synergy and balance.

<u>For example:</u> Many novices Squat utilising machine weights, what happens then when they get home in the afternoon and attempt to lift a box. The muscles may be further developed but how has the synergy, proprioception and balance improved to aid in the movement? To see this in action compare a novice weight trainer doing a free squat and a universal squat. Which one do they wobble around more on?

> '*Since pin weight machines consist of preset lines, it is often argued that the stabilisers are neglected. It is often these stabilisers that are prone to injury.'* (McEvoy, Rawson & Ridley, 1993)

♦ *Biomechanical Design :*

Not only do machines fail to follow the body's natural strength curves (Zatsiorsky,1995; Shield,1995), but by fixing lines and planes of movement the chance of injury may actually increase as opposed to decrease. Poliquin (1997 as cited by Ostrowski 1998), in regards to the smith - machine bench press, states that….

> *Because of the mechanics of the human shoulder joint, the body will alter the natural pathway during a free - weight bench press to accommodate efficient movement at the shoulder. A fixed - bar pathway does not allow variation for efficient movement at the joint, thereby predisposing the shoulder to harmful overload from the lack of accommodation.*

With this in mind and the curvilinear movement created by the musculo-skeletal system across articulations, simple circular or linear resistance based machines do not allow the articulations to follow their natural movement patterns and hence increase the chance of injury.

Furthermore, when lever systems are utilised, friction created by the rollers and slides add to the total weight lifted. This friction is less in the lowering actions of these machines (now gravity assisted). This would mean that when performing a concentric action the muscle moves a greater load than when contracting eccentrically. This eccentric unloading does not suit the capability profiles of muscles, being that eccentric contractions are stronger than concentric ones (Shield,1995). In line with this, often the position in which the muscles are loaded is inappropriate. For example the start of the Pec Dec where the arm is often fully abducted and externally rotated and the start of the Leg Extension where the knee is not only fully loaded in an open joint position but the start angle is often greater than 90*. Both of these positions not only have to overcome Neuton's first law, but also suddenly become maximally loaded.

Exercise Considerations

♦ *Function or Counter Function?*

In the rush to jump on the '*functional training'* bandwagon, many people forget a simple fact. Consider; if all of our training is towards functional life and we perform certain activities everyday for our functional needs … would not the muscle groups used continually receive a greater training stimulus? Would this therefore not create muscular imbalances and hence decrease our TRUE INTENDED functional goal? Almost everything we do in life is in front of us; eating, reading, typing, writing etc. All these actions require shoulder flexion and horizontal shoulder adduction (often internal rotation as well). Thus muscles like the Pectoralis Major / minor and Anterior Deltoid are used to a high extent daily. Do we therefore want to increase our stimulation of these '*functional'* muscles? Or would it be more advisable to prescribe counter functional training? What tends to make these matters worse is the '*mirror training syndrome'*; the syndrome where only the biggest muscles that can be seen in the mirror are trained. Muscles like the Pectoralis Major / Minor, Anterior Deltoid and Latissimus Dorsi, all internal rotators, are constantly pounded in either isolation or compound movements. Although when remembering to stand up straight these people may look 'buff' most of the day when they are not flexing and 'puffing up' they look like hunchbacks with a kyphotic posture – Add to this the thousands of rectus abdominous training and they almost collapse inwards.

Therefore in training, counter functional work should be considered to help decrease injuries created by excessive functional training and actions.

♦ *Biomechanics*

The biomechanical effects of an action and the lever system created by the musculo-skeletal system at the articulation need to be considered when selecting and implementing a training exercise. Consider the squat. A current concept in vogue is to not allow the lower limb to move forward when squatting, thus leaving the knees above the heel and pushing the hips further to the rear. This methodology considers the protection of the knee by decreasing range of motion over the knee joint thereby increasing the load on the hip extensors. It forgets however basic biomechanics. With the hips pushed further to the rear to compensate for the lack of forward knee movement, the lever arm is increase between the fulcrum (the hips) and the load (the bar). This increases the load on the lower back and increases the potential of lower back injury. Considering this, the current technique methodology still advises a combination of hip and knee loading (as opposed to overloading one or the other) unless undergoing rehabilitation or otherwise advised by a Doctor or Physiotherapist.

♦ *Speed of Movement*

The speed at with which contractile proteins form or break during cross bridge cycling governs the amount of tension that can be produced (Fleck & Kraemer,1997). The Force - Velocity Curve shows that although the faster the ***decrease*** in muscle length the ***weaker*** the concentric contraction becomes and the faster the ***increase*** in muscle length the ***stronger*** the eccentric contraction becomes (Fleck & Kraemer,1997; Zatsiorsky,1995; Shield & Young,1995; Wilmore & Costill,1994; deVries & Housh,1994).

It is suggested that the following two points be considered when determining speed of movement.

1. If only one velocity is trained at it should be of a medium speed; approx 95 - 180 degrees / seconds (Fleck & Kramer,1997).
2. Any training velocity increases strength in a range above and below the training speed (Fleck & Kramer,1997).

- *Stabilisation and Balance Profile*

The transferability of gains made on machines are questionable. Chek (1997) explains that motor patterns are centrally generated and if the body is not satisfied that the core is stable it will decrease the activation of the larger muscle groups.

If the stabilising muscles of the shoulder joint are weak then innervation of the prime movers will decrease during the performance of a movement. (Ostrowski 1998, on developing the stabilisers for the Bench Press.)

You can only pull what you can stabilise. (Chek 1998b, on Bent Over Rowing.)

It is important to develop active, internal stabilisation as opposed to passive external stabilisation. (Ellison 1995)

The more you stabilise a movement the stronger the movement becomes, transferability from functional to stable exercises is therefore high, yet these gains are low in the reverse situation. Ostrowski (1998) uses the example of the Lat Pulldown and the Chin Up. Increases in the Chin Up are transferable to the more stable Lat Pulldown, yet not the other way around. Furthermore motor patterns are in fact, reversed with the chin up being a closed chain activity whilst the lat pulldown is an open chain activity.

Another stabilisation consideration is the nature of the stabilisation required; is it 'balancing' or 'counter balancing'. Not only is core strength important but so to is the body's proprioceptive abilities. Consider the proprioceptive needs of an ankle required to stabilise a body on landing (with the platform non – moving, the body stabilises by 'balancing') as opposed to one stabilising on a surfboard (the body having to 'counter balance' as the platform moving). Which ankle proprioceptive exercise would you give to enhance each activity?

- *Synergy*

One of the most notable factors in strength gains for beginners comes from an increase in muscle synergy (Sharkey 1990; Shield 1994; Wilmore & Costill 1994; Fleck & Kraemer 1997). This is because the motor pathways develop to make the action more efficient by not sending neural impulses to the antagonists and non-essential muscles. Synergy develops to allow a coordinated activation of the agonists, synergists and fixators in their correct roles, without interference from the antagonists. (See Figure 3.)

The body adapts to the level of performance required. If the level required is below the current level developed, then detraining will take place (Eg. When you take time off, your body detrains to your current sedentary levels). For the sedentary person who takes up resistance training, there is a positive adaptation to the new level of synergy and stabilisation required, (the inter muscular adaptations that bring strength gains.). However for the general resistance trained individual, who performs the generic isolated, machine or supported exercises, the stabilisation / synergy requirement is still below that required for functional activity and sport. With this in mind, strength for function needs to be developed in a functional setting, (remembering that strength is transferable from an unstable environment to a stable environment but not the other way around.)

The means in which stabilisation is increased is also important. In the upright position humans use their abdominals as stabilisers as opposed to just movers. How many functional activities and sports require their strength in the upright position, almost all of them. As Ellison (1995) states '*A muscle's function in the upright position is a priority in training*.'

PROGRAMMING FOR FUNCTION

1. The first thing to do to each exercise is add more movement, rather than moving only one joint, move more. The more they move the more functional the exercise. Compare the amount of joint movement in a leg extension as opposed to a Deadlift or even a run. For circuit training decrease the isolation exercises like Triceps extensions and increase the compound and complex activities.
2. Furthermore, decrease the influence of pre-fatiguing exercises. If you want the triceps muscle to be the dominant factor in the Push Up, Mil Press, Bench Press etc. then isolation before compound / complex may have a place. If however you want to fatigue the larger muscle groups, then the fatigued triceps may limit you.
3. If isolating for rehabilitation remember, rehabilitate then integrate.
4. The next thing to do is to decrease support and increase the requirement to balance. Moving off the machines and onto free weight can do. Once barbells have been mastered move onto dumbbells. From there the choices are endless. Use medicine balls, body weight, and ropes Throw away the bench and use a fitball or dura discs or cables.
5. Consider the synergy, force development patterns, balance and speed of movement profile for the sport or every day (including working) lifestyle of the person you are writing the program for.
6. When prescribing and advising on exercises and their techniques consider the anatomical, biomechanical and kinesiological effect of the exercise.
7. Consider the asymmetric profile, is there a muscle imbalance? Is there a need for counter – functional training in order to become functional?

8. Progression is the most important aspect of programming. It is hard, due to ego, but vital that they start at the beginning. The method of progression should be from techniques and stabilisation to strength then if required power. '*We should never break the stability - strength - power rule of progression or we break the client/athlete'* (Chek 1998a).
9. I know…the primary goal is often aesthetic, they want the muscles of their legs to look good, so they want to do Leg Extensions and Leg Pressing...Ever seen a sprinters legs? Pec Decs and Flyes for the Upper Body? Seen a gymnast? Yes they do perform weight training exercises, but their dominant training is kinetic link and they do their weight training after functional training.

Easy is it not? However there is a catch. By decreasing their stability and increasing their balance requirement, the weights they can normally lift need to be decreased.

Safety**Safety****Safety****Safety****Safety**

1. Follow the guide of developing technique and core stabilisation ***FIRST*** then Strength then Power.
2. Move from exercises with the higher stabilisation requirement to those more stable during a training session.
3. Progression - DO NOT increase weight too rapidly -------Remember first rule.

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