"Lengthening longer, Strengthening stronger" - Eccentric Training + Living Longer Living Stronger.

As an evidence-based program, Living Longer Living Stronger has always prided itself on providing the very best available physical training for over 50's in Western Australia. We stand by the progressive strength training we provide to our Seniors; and the track record suggests that it has been instrumental in helping many achieve their best possible quality of life.

We have recently been briefed by Professor Ken Nosaka of the School of Medical and Health Sciences at Edith Cowan University on the work he has been doing in the field of Eccentric exercise training. Living Longer Living Stronger has had a long and fruitful relationship with Edith Cowan University's Vario Wellness Clinic. We feel it is important to share this information with all of our Instructors and Providers of Living Longer Living Stronger, so all participating Seniors can benefit.

Concentric muscle training vs. Eccentric muscle training

What do we mean by Eccentric exercise training?

Concentric muscle contraction is where tension is placed upon a muscle while it shortens. A good example of this is during a bicep curl when the weight is drawn towards the body. Another example is the pressure placed on the quadriceps (thigh muscle) when running uphill or climbing stairs. Concentric exercise training is the "standard" focus of movement for many exercise programs.

Eccentric muscle contraction is where tension is placed upon a muscle while it lengthens. In the bicep curl, resistance applied to the weight as the arm descends to full extension is an Eccentric muscle exercise. Another excellent example of Eccentric exercise is descending stairs – as the pressure and resistance is placed upon the quadriceps while it lengthens.

When the load is greater than the force applied (applying, say 8 kilos of resistance to 10 kilos of load) while the muscle lengthens, this is Eccentric exercise.

What the research shows

We know that exercise is the best medicine. Recent review article (Pedersen and Saltin, 2015, *Scandinavian Journal of Medicine & Science in Sports* : available at http://onlinelibrary.wiley.com/doi/10.1111/sms.12581/full) confirms that exercise has a positive effect on the treatment or therapy of some 26 different chronic diseases.

The question often comes down to "which exercise" is best?

Professor Nosaka has been involved in trialling Eccentric exercise (as distinct from Concentric exercise), and his findings have been enormously significant for the field of Seniors' health and fitness. He and his team's findings reflect and confirm the global research that shows that the gains from Eccentric exercise simply dwarf those from Concentric muscle based activity (the focus of standard exercise programs).

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He has recently completed fresh research with two groups of Seniors that would seem to indicate that Eccentric exercise even has a greater impact on cognitive health and diabetes management-: https://www.ecu.edu.au/news/latest-news/2016/04/exercise-Eccentrically-for-possible-brain-boost

We have a copy of this exercise program (Stay Sharp) that we may make available when the images have been replaced (Professor Nosaka used photos of his daughter modelling the exercises and for privacy reasons we think it best to update them). We do, however, describe the exercises used in the following section for both individual and paired activity.

While we at COTA have been made privy to the results of the most recent research, we cannot cite the numerical data until it is published. However, they reinforce previous findings of Professor Nosaka – such as in the following study-:

Measuring Knee Extensors (KE) with a near identical group of men aged 60 – 76, the study examined the impact of progressive Eccentric training (building from 10% to 100% of maximal 1 repetition load based on Concentric knee strength over twelve weeks) versus progressive Concentric training (building from 50% to 100% of the same load over twelve weeks). Each group exercised once a week for 12 weeks.

The study measured a huge range of metrics ranging from heart rate, systolic and diastolic blood pressure; bone mineral density; as well as upper thigh circumference and voluntary Concentric contraction. A wide range of functional fitness and balance tests were also used including 30 second chair stands, 2 minute step, 6 minutes walk, one leg stand test with eyes opened and eyes closed. Blood samples were also collected for HbA1C (haemoglobin/diabetes measure) along with insulin sensitivity, cholesterol (total, low density and high density).

The results were striking. In terms of statistical significance ($P \leq 0.05$) :

1. Resting heart rate, systolic and diastolic blood pressure and pulse wave velocity measured between carotid and femoral artery all improved significantly more with Eccentric training than Concentric training
2. Muscle strength and upper thigh circumference increased by around double by Eccentric training in most measures
3. Several functional physical fitness measures (e.g. 30 second chair stand, one leg stand) showed greater results in Eccentric rather than Concentric training
4. Improvement of Insulin sensitivity was ONLY significant with the Eccentric training group
5. Greater decreases in low density cholesterol, tricylglycerols, and increases in high density cholesterol during Eccentric rather than Concentric training.

Please see the attached poster for the data from this study.

It notes in summary that "it is better to focus on Eccentric than Concentric contractions to improve health and fitness of an elderly individual." Other research confirms this – in virtually all measures taken, the gains from an Eccentric focus are greater than Concentric focus in the fields of strength,

muscle mass, co-ordination, balance, flexibility, the prevention of muscle injury, and tendon rehabilitation.

In short, this means that we should be focusing on Eccentric exercise prescriptions more than Concentric exercise prescriptions in Living Longer Living Stronger program to ensure that our Seniors are receiving the best possible training and results. Here follows some useful practice guides to incorporating Eccentric focus with Living Longer Living Stronger exercise prescriptions.

Delayed Onset Muscle Soreness

The huge, basic problem with prescribing Eccentric exercise training has been the impact of **Delayed Onset Muscle Soreness (DOMS),** which is far more pronounced for Eccentric than Concentric training. Given that many Living Longer Living Stronger clients are returning to exercise after a long break, or even engaging in an exercise program for the first time, ensuring that they are not "put off" by excessive pain is a key to achieving success.

Professor Nosaka has identified three strategies that reduce DOMS, and make focusing on Eccentric training possible with Seniors. It is vital that you use one or more of these strategies prior to engaging in an Eccentric training program with your clients, as a traditional "warm up" does not work!

1) Pre-conditioning exercise

Eccentric muscle training is an unusual movement for many – as it involves resistance during the lengthening of the muscle. Even some professionals can scratch their heads when thinking about how to move in an Eccentric way (tips follow). The body is no different, and requires a "primer" session to accustom the muscle group to Eccentric movement.

Professor Nosaka recommends an initial session of "5 minutes, not 30" – and starting with very light-intensity (e.g. 10% of Concentric 1 rep max load) for the first couple of sessions in Eccentric training.

Remarkably, this "primer" session will mitigate DOMS more than 50% even after maximal eccentric exercise performed within a week! However, it is most effective in mitigating DOMS for two days, and this "priming" gradually reduces over the course of three weeks. Conducting this priming session with your clients will enormously reduce DOMS – gradually increasing from this point will yield optimum results.

2) Isometric contraction (at long length)

Another method of reducing DOMS is by engaging in an isometric training session at a long muscle length. Isometric training can involve the body's own structure + ground, pushing against static items (such as a wall), or holding weights in fixed positions (as long as the client is static and joint angle and muscle length do not change, of course!).

- 2 maximum isometric contractions results in the reduction of DOMS after maximal eccentric exercise session by 20%
- 10 maximum isometric contractions results in the reduction of DOMS after maximal eccentric exercise session by 50%

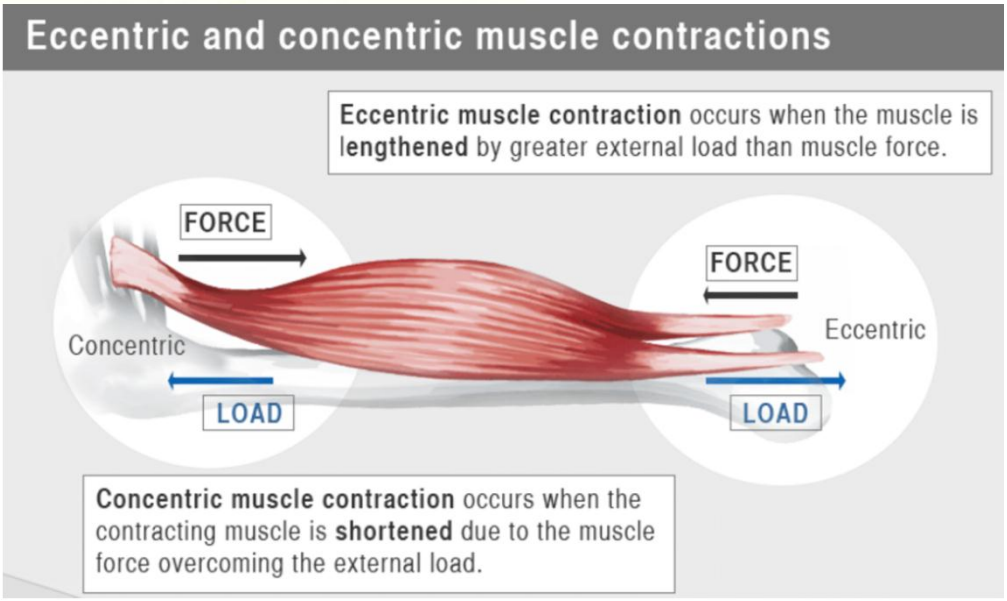
3) Muscle pain mitigation

Should DOMS still be experienced by the client, Professor Nosaka has also completed research that has isolated the source of soreness – it results from the fascia – the muscle sheaths just beneath the skin. Light surface massage of the fascia may reduce DOMS (more than deep tissue massage) if it occurs, and you should advise the clients of this strategy.

The important question… HOW do we use this for our clients?

There are a huge range of Eccentric exercises that can be used either singly or with a partner, and would be appropriate for use in Living Longer Living Stronger as part of an individual program or paired activity (some suggestions follow). Crucially, existing exercises can be adapted to more effectively utilise the Eccentric phase!

As previously stated, when the force applied is less than the load (applying, say 8 kilos of resistance to 10 kilos of load in a bicep curl during the extending phase), it activates tension in the Eccentric group, as the load over the force pressures the muscle to lengthen.



While it may not be possible in all activities to completely isolate Eccentric movement from the whole exercise, a change in **FOCUS** still provide the extended gains of Eccentric training.

For example, with a bicep curl :

1. **Quickly** draw the weight toward you (in a "one" count)
2. **Slowly lower the weight to full extension over the course of five seconds**
3. As the count extends (1-2-3-4-5), exert more and more pressure with each number
4. The force exerted should be largest just prior to full extension.

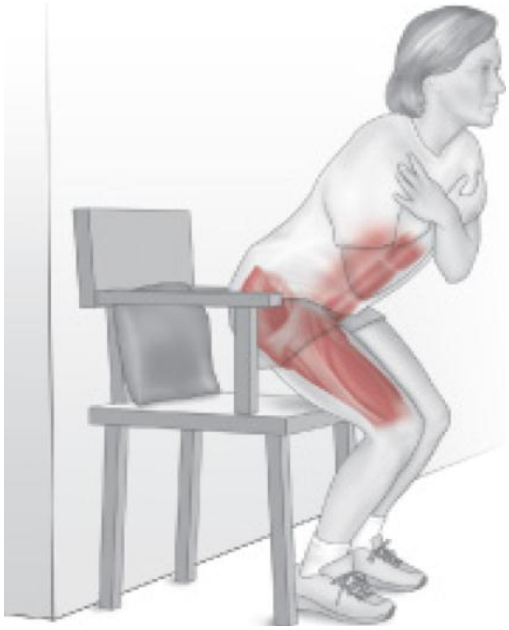
As a training tip – imagine (or count out loud) the number (1-2-3-4-5) getting louder and louder (from one to five). As the number gets louder, increase the force!

Some general guidelines for clients/participants that may be helpful

- Concentrate on "eccentric" contractions
- Start with "low-intensity" resistance
- Gradually increase the resistance at the end of contraction
- Do not hold your breath – breath normally
- Take time between repetitions (e.g. 30 s) and between exercises (e.g. 1 min)
- If any pain is felt, stop the exercise, and notify Instructor
- Repeat the exercises 2 or 3 times in a session
- Feel for the muscle being lengthened or stretched
- Focus on the muscle being used

Single exercises

Using the same "Increase the force exerted 1 to 5 in the lengthening phase" method – here are some exercises that have been used in the Stay Sharp program by ECU. As always, you should be using the medical and prescription history of your individual client to assess suitability of these or any exercises :



Chair squat
Stand up with a support, and sit down slowly
10 reps

Knee push down
While lying down, pull knee up and hold, and push it down while resisting
5 reps per leg

Toe push down
While sitting, with toe pointing up, push it down with other foot
5 reps per leg

Heel down
Raise heels, and go down with one leg while standing
5 reps per leg

Front lunge
Step forward and bend knee, then stand up straight (slowly)
5 per leg

Side lunge
Step to the side and bend knee, then stand straight (slowly)
5 per leg

Back step
Step backward and stretch calf, then stand straight (slowly)
5 per leg

Elbow push extension
(Sitting or standing) Extend elbow straight while resisting with other arm
5 per arm

Elbow pull flexion
(Sitting or standing) Flex elbow fully while resisting, using other arm
5 per arm

Floor kiss
From a "push up" position - bend elbows slowly to bring face close to floor
10 reps

Slow back down
While sitting on floor, lie down on the back slowly
10 reps

Slow chest down
While lying on stomach, raising chest rapidly, then lower chest slowly
10 reps

Extended (Level 2) Single Exercises (be careful of client balance with this group)

One leg chair squat
Stand up with both legs, and sit down slowly with one leg
5 per leg

Nordic hamstring
Kneel on a floor and lean forward slowly using the hamstrings as a brake
10 reps

Calf stretching
From a standing position, stretch one calf with heel touching the floor, and bend knee as much as possible
5 reps per leg

Heel walking
From a standing position, lift toe up and walk backward with heels
10 reps

Reverse push ups
Sit on a floor and raise posterior, slowly bend elbows to lower posterior
10 reps

Sit ups
Lay on a floor bending knees. Sit up quickly, then slowly go back to the starting position
10 reps

Leg raise
Lying on stomach, raise legs off the floor, and slowly go back to the starting position
10 reps

<u>Paired activities</u>

Elbow extension - Elbow flexors
Seated position -Try to resist when the elbow joint is extended by a partner (pulling on forearm)
5 per arm

Elbow flexion - Elbow extensors
Seated position - Try to resist when the elbow joint is flexed by a partner (pushing on forearm)
5 per arm

Chest extension - Chest flexors
Seated position - Try to resist when the chest is extended by a partner (pushing forearm outwards)
5 per arm

Hip extension - Hip flexors
Seated position - Try to resist when the knee is pushed down from a raised position by a partner
5 per leg

Hip adduction - Hip abductors
Seated position – With legs open, try to resist when the knees are pushed in by a partner
10 reps

Knee flexion - Knee extensors
Standing - Try to resist when the shoulders are pushed down by a partner (over chair! Watch balance!)
10 reps

Knee extension - Knee flexors
Laying on front on ground, with knees bent, try to resist when the knee joints are extended by a partner (pulling on leg)
10 reps

Ankle planter-flexion - Ankle doesi-flexors
Sitting on ground with legs flat and feet pointing upwards, try to resist when the insteps are pushed down by a partner
10 reps

Ankle dorsi-flexion - Ankle plantar-flexors
Sitting on ground with legs flat and feet pointing downwards, try to resist when the soles are pushed up by a partner
10 reps

Trunk extension - Trunk flexors
In seated position - try to resist when the chest is pushed backwards and down by a partner
10 reps

Trunk flexion - Trunk extensors
Laying on front, arch back and try to resist when the back is pushed down by a partner
10 reps

In summary

Eccentric training provides greater gains for strength, muscle mass, co-ordination, balance, flexibility, the prevention of muscle injury, and tendon rehabilitation for Senior clients than Concentric training. Additionally, the gains for insulin resistance, cardiovascular health, and potentially cognitive health are greater than exercise programs with a Concentric focus.

Eccentric focused exercise is possible to implement in gym based settings without major changes to equipment or training (although both are desirable!).

Living Longer Living Stronger *could thereby look at shifting the focus of exercise prescriptions for Seniors clients from Concentric to Eccentric training for greater gains.*

When prescribing Eccentric exercises for clients, Instructors should :

1) Ensure medical and prescription history obtained (as per regular LLLS program)

2) **Ensure DOMS management strategy in place** (essential!) using either :

   - Pre-conditioning/priming sessions (following guidelines)
   - Isometric conditioning (following guidelines)

3) Monitor Participant while progressively increasing reps, resistance and varying exercise base