Information Letter to Participants

The Effect of Unilateral Resistance Training on Neuromuscular Function and Adaptation

Thank you for expressing your interest in this research study. The purpose of this information letter is to explain the study that you may choose to participate in. Please take a few minutes to carefully read the information below, and do not hesitate to ask any questions regarding the study methods, equipment or safety concerns. If you agree to participate in the project, you will be asked to undertake a screening process to evaluate if you meet the study’s inclusionary criteria.

Project background information

It was once believed that the responses generated due to training were confined to the muscle groups actively involved in resistance training. However, a phenomenon exists where undertaking single limb training, also called “unilateral training”, enables the transfer of a response to the same muscle but on the opposite limb, also called “contralateral limb”. This phenomenon is referred to as the cross-transfer effect. The activation of the cross-transfer effect has important implications in rehabilitation settings, especially for individuals with an immobilised limb due to a musculoskeletal injury or recovering post-surgery. An adverse effect of immobilisation is the decay of functional and physiological adaptations that occur in that limb, prolonging the recovery time needed to restore neuromuscular function.

Previously, the simultaneous implementation of unilateral training and the immobilisation of the contralateral upper limb has retained neural and muscle function in the contralateral muscle. However, there is little research that has investigated the effect of unilateral training using different training intensities on the retention of these properties immediately after a period of training.
Purpose
The overall purpose of this research is to expand the current understanding of the adaptations influencing the development, retention, and decay of neuromuscular function due to unilateral training.

Methods
All testing and training sessions will be performed at the ECU Exercise Physiology Laboratory (19.150) and ECU Strength and Conditioning Laboratory (19.149) at Joondalup, respectively.

Participant Requirements
As a participant, you must be aged between 18 – 35 years and are not currently undertaking deliberate resistance training of your upper body. You must also not have previously experienced a musculoskeletal injury to the upper body that required clinical assessment within the last two years and not currently using anabolic or anti-inflammatory medications. If you decide to participate and are deemed eligible, you will be asked to attend the laboratory on 34 occasions over an 11-week period – approximately 3x per week on non-consecutive days. Before any testing and training sessions, you will be asked not to consume caffeine or alcohol for 6 and 12 hours, respectively. For the first and third sessions of every testing block, all participants will be asked to wear a singlet to assist in the placement of electrodes and with testing with the Peripheral Quantitative Computed Tomography (pQCT).

What will I be required to do
In the first visit, you will be familiarised with all of the experimental equipment and procedures of the study including; (1) maximum voluntary isometric contractions (MVIC) and rate of force development (RFD) testing of the elbow flexors, (2) maximal contractions at different velocities on the dynamometer, (3) dumbbell biceps curls on the preacher bench, (4) electromyography (EMG; passive recording of the electrical signals from your muscles), and (5) magnetic transcranial (at the head) and electrical peripheral nerve (at the shoulder) stimulation. The familiarisation session will take approximately 60 – 90 minutes to complete.

The pre-testing measurements will be performed during the second, third and fourth visits. You will then complete a 4-week moderate-intensity resistance training program of
the elbow flexors, that will take approximately 20 minutes for each session, before performing the first of two post-testing periods (same tests as in the pre-testing period).

You will then be randomly allocated into one of four 4-week maximal strength or power training groups: (1) no training; (2) unilateral maximal strength training; (3) unilateral power training; and (4) bilateral maximal strength training. The training sessions in this second training block will take approximately the same amount of time as previously undertaken. The final post-testing period will be completed following the second training program.

**Testing Session 1**: This testing session will consist of static, also called “isometric”, strength and neurological testing. Upon arrival at the laboratory, you will be taken through a preparation period where we will apply skin-based self-adhesive EMG electrodes to the biceps brachii muscles of both your upper arms to record muscle activity. The area underneath the electrodes will be lightly abraded and cleaned with alcohol to minimise the risk of infection. After EMG preparation, an electrode will be placed near your collarbone which will be the site of the electrical peripheral nerve stimulation. The dynamometer will then be set-up to suit your body dimensions and the settings recorded for ease of later sessions.

Before undertaking testing, you will complete a standardised warm-up of three submaximal sets of biceps curls. After completing the warm-up, you will complete three MVIC and three additional RFD trials lasting no longer than 3 seconds each. After these functional tests, the neurological tests will follow. For these measurements, the researchers will measure the dimensions of your head to allow them to find specific areas of your brain. The researchers will then get you to put on a snug-fitting cap with reference dots all over it to make it easier for the researchers
to find the same point on your head across the session. Low-level magnetic stimulation will then be generated by the transcranial magnetic stimulation (TMS) device to activate the part of your brain representing your upper arms. There will be several of these low-level stimulations; however, they are painless. The peripheral nerve of the upper arm will be activated from a low-intensity to a maximum intensity to determine your potential ability to activate the muscle fibres of your biceps brachii muscles. Again, there will be a few of these stimulations on the peripheral nerve. However, the number of maximum stimulations will be limited to 4 on each arm. This session will last approximately 3 hours. For this session, all participants will be asked to wear a singlet to assist in the placement of electrodes on the upper arm and shoulder areas.

**Testing Session 2:** This session will consist of dynamic strength testing at different velocities and one-repetition maximum (1-RM) testing of your elbow flexors using dumbbells. After completing the warm-up, you will complete three trials of maximum strength testing at fast and slow elbow flexor testing velocities. Afterwards, the 1-RM testing will involve both unilateral and bilateral, e.g., both arms at same time, strength testing. A few trials will be required to determine your 1-RM strength to the nearest 0.5 kg for both unilateral and bilateral 1-RM testing. This session will last approximately 45 min.

The pQCT device will be used to scan the upper arm which uses x-ray (low-level radiation dose) to measure muscle and bone structures. When scanning, you will be positioned on your back with your arm out to the side and centered in the pQCT machine gantry. You will keep your arm motionless for ~4 min while the scan is completed. This session will last approximately 30 min. For this session, all participants
will be asked to wear a singlet to assist in the placement of the upper arm in the pQCT gantry.

**Training Sessions:** The training sessions will only consist of strengthening your elbow flexors. The first 4-week training program will consist of three sets of 8 – 12 repetitions of preacher biceps curls, with the load set at 75% of your 1-RM and a 2 min interset rest interval imposed. A metronome will be used to provide you feedback regarding your movement speed. The second 4-week training program will either consist of maximal strength, power or no training. If you are selected into the maximal strength training group, you will perform four sets of 4 – 6 repetitions at 90% of their 1-RM. Similarly, a metronome will be used to provide you feedback relating to your movement speed. If selected into the power training group, you will perform four sets of six repetitions at 30% of their 1-RM. The lifting phase of the exercise will be completed as rapidly as possible. A rest interval of 2 min will be prescribed for both the maximal strength and power training groups. If you are selected into the no training group, you will not be asked to train during this period. You will be asked to maintain your normal lifestyle activities.

**Benefits of study participation**

You will have the unique opportunity to learn about and observe advanced neurophysiological techniques that probe the activity of the intact human nervous system, particular the central motor pathway controlling muscular force production and human movement. You will also have the opportunity to learn about the development of research strategies and research design as well as ask questions about research or any aspect of sports science, neuroscience and the role of neuroscience in sports science research. Additionally, you will get the opportunity to undertake upper arm resistance training for FREE under the supervision of an accredited Sports Scientist, Strength and Conditioning Coach and trained first aider.

Results from your participation will further our understanding of the effects of unilateral training on developing, retaining, and attenuating the decline of neuromuscular function. Understanding this response is relevant for athletes, individuals injured after recently undertaking a resistance training program, and clinical practitioners interested in the
effects of prehabilitation to improve the recovery rate of their patients before a planned upcoming surgery.

**Potential risks of study participation**

There are some discomforts/risks associated with the procedures being employed in this study. Some of the procedures are considered uncomfortable, but they should not be painful. You will be asked to perform maximal muscular contractions of your elbow flexors so there is a very small risk of fainting, exhaustion, cardiac events, i.e., heart attack, angina, and musculoskeletal injury, as well as impairment to your ability to perform tasks such as driving after the completion of exercise; however, this risk will be minimised using a standardised warm-up, test familiarisation and monitoring of physical symptoms throughout the sessions.

The use of transcranial magnetic stimulation (TMS) may cause small twitches in the scalp, face or arms, and cause small movements of the limbs being targeted. Stimulation of these additional areas is sometimes unavoidable due to the overlapping of the motor areas in the brain. On rare occasions, TMS may cause muscle tension headaches, which are usually mild and easily treated with aspirin. Accidental seizures with someone who has no known history of epilepsy or fainting are possible but have not been reported since safety standards were implemented in the mid-1990s, and only reported in high-frequency, high-intensity repetitive stimulations. In the present study, we will be delivering single-pulse currents thus the likelihood of either occurring is low. No side effects have been reported with the procedures we will be implementing, and the present study meets the current safety standards for this technique as discussed by Rossi et al. (2009) and Rossini et al. (2015). Additionally, the light skin abrasion performed before application of the skin-based EMG electrodes can increase the chance of skin infections. To minimise this risk, alcohol wipes will be applied to the skin after abrasion as well as after removal of electrodes.

The use of the pQCT device will enable the researchers to measure the changes in your muscle size during the study. You will experience no pain by being tested with this device. However, you will be exposed to a very-low localised dose of radiation due to the x-ray source. The pQCT has been designed to be safe and it compiles with all the regulatory requirements enforced by national and international laws. To put it in perspective, the effective radiation dose of the scan generally ranges from 1 – 6 µSv.
which is a much lower range than generated from diagnostic x-ray procedures. Moreover, this effective radiation dose is about equal to one thousandth of the background radiation you would receive in one year living in Perth. The total background radiation in Western Australia is about 2 mSv per year. The radiation dose from cosmic rays from flying in a jet from Perth to London return is approximately 0.1 mSv. Also, the radiation dose will be directed to your upper arm which reduces the effective dose on the body. However, if you are a female and pregnant or there is a chance you may become pregnant during the course of the study, you will be excluded from participating in the project. This rule will only be enforced to eliminate any unnecessary risks to the fetus. Please tell the researchers if your pregnancy status changes.

All experimental sessions will be completed under the supervision of a qualified researcher and accredited strength and conditioning coach (Mr. Grant Rowe). We will remind you to tell us immediately if you experience any pain during the experimental procedures. If, at any stage, you are uncomfortable or want to stop the test, you will be free to withdraw from this study at any stage without reason or prejudice.

**Confidentiality of information**

Information collected will only be available to Mr. Grant Rowe and his team of researchers. Your personal data will be assigned an identification code, such that only those people directly involved in collecting information for the study will be able to recognise which person the information pertains to. So that personal information cannot be assessed by those external to the study, all personal data will be stored securely – data collection sheets (hard-copies) filed and back-ups saved on an external hard-drive, in locked cabinets in the School of Medical and Health Sciences offices. All collected information will be retained for a period of 10 years after which the information will be destroyed.

**Results of the research study**

The results of this study will be used for the completion of a Doctorate of Philosophy degree and may be presented at conferences/seminars and published in peer-reviewed academic journals, as magazine articles, as an online article or part of a book section or report. Additionally, the results of this study may be used in future projects. Because of reporting methods of this project, no identifiable individual data will be published or presented, meaning your personal information cannot be identified unless specific consent
for this has been obtained. A copy of the published results can be obtained from the chief investigator upon request.

**Participant rights**

Your participation in this study is voluntary. No monetary reward will be provided. You retain the right to withdraw from the study or refuse single measurements at any time, and no justification or explanation is needed if you choose not to participate. There will be no consequences for your withdrawal or refusal of single measurements. If you are a student, your grades/assessments will not be impacted should you decline to participate in this study, nor will it affect your relationship with Edith Cowan University. Reporting of study findings will be done with complete confidentiality and your identity will not be disclosed to any party outside of the study at any time. You also have the right to withdraw any personal information and/or data that has been collected during the research prior to publication. This will be achieved by deleting your results from the laboratory laptop hard-drive and external hard-drive and shredding documents and securely disposing them. Lastly, you have the right to receive information regarding your own data/results at any time during the study from a member of the research team.

ECU Human Research Ethics Committee has approved this research project. Should you have any questions relating to any of the information provided above, please feel free to contact me or my research supervisor, Assoc. Prof. Greg Haff, for further explanation. If you have any concerns about the research, or would like to speak to an independent person regarding any issue, including withdrawing from the project if you feel uncomfortable discussing this issue with the chief investigator or principal supervisor, you may contact the ECU Human Research Ethics Committee. All contact information is below.

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Sincerely,

Grant Rowe