Title: A conceptual framework of different eccentric training methods.

Short Title: Eccentric training framework.

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ABSTRACT

There are various methods of eccentric training that aim to increase muscle mass or reduce ground contact time during a landing task have been extensively researched and practically examined. However, multiple methods to implement eccentric training currently exist; they differ in execution and intended training adaptions. There is a clear differentiation between an eccentric muscle action and an eccentric motion whereby a motion alludes to a downward movement of an exercise. The proposed eccentric motions are dissipating eccentrics, deceleration eccentrics, overcoming eccentrics, maximal eccentrics, and rebound eccentrics. These motions formulate into training methods and cues to allow practitioners to clearly differentiate the various eccentric training methods utilized in research and practice. This review proposes a new conceptual framework that clearly outlines the different forms of eccentric motions that fall into a desired eccentric training method.

Key Words: Muscle action; Exercise phase; Landing; Coaching cues; Eccentric training.

INTRODUCTION

Recently, the focus on eccentric muscle actions and associated training techniques has increased substantially. For strength and conditioning (S&C) and sports science practitioners, this uptake is associated with the ever-growing research (4,5,14,21,22,24,30) recognizing the unique adaptations following eccentric training (21,27). Eccentric muscle lengthening occurs in several daily tasks, including walking downstairs and lowering to sit on a chair (20). Furthermore, eccentric muscle actions are present in sporting tasks such as sprinting, landing, and downhill skiing (14,26,29,30). The muscle action is primarily thought to act as a damper to dissipate and release energy or increase concentric force output during stretch-shortening cycle (SSC) tasks (4,40,45,46).

Eccentric training methods such as accentuated eccentric loading (AEL) have led to increases in specific physical adaptions such as eccentric overload exercises creating greater muscle mass gains than isoinertial training (43). This has led to greater force production capacities and a subsequent enhancement in surrogate measures (e.g., rate of force development) of athletic performance compared to concentric training (5,10). Due to the common occurrence and importance of eccentric muscle actions in sporting tasks, there has been a significant increase in research aiming to understand how to best apply eccentric training techniques and which are used most in practice. This is illustrated in the survey studies by Drury et al. (11), Harden et al. (18), and McNeill et al. (27), who highlighted that tempo training was the most frequently used within practice. Furthermore, Mike et al. (30) and Suchomel et al. (37,38) provide theoretical and practical application understanding to various eccentric training methods such as AEL and the 2-1 method. These all aim to better understand how various eccentric training methods can be utilized within practice.

Eccentric training techniques now encompass a variety of approaches ranging from supramaximal AEL (19,38,43) to the shock method (exercises such as the depth jump) (42) and manipulation of time under tension during tempo training (24). However, each of these methods vary in terms of their mechanical demand and, therefore, results in different physiological adaptations such as muscle mass increase and deceleration ability. Hence, it is sensible for greater clarity regarding the exact nature of the motions during different eccentric training techniques. During different exercises, there is limited understanding of the differing eccentric actions that likely occur (e.g., when comparing the eccentric actions of a drop jump and Nordic hamstring curl, which have different executions and endpoints). Eccentric training techniques are limited without consideration for different strategies based upon the unique eccentric muscle motions that various exercises utilize.

Harden et al. (17) noted that eccentric training had become an umbrella term encompassing various training techniques designed to achieve specific physiological adaptations. Although no issue with this has yet arisen, introducing global definitions would allow greater clarity across academia and practical implementation. As such, an in-depth review of eccentric motions and how they can be best defined and their associated training techniques is warranted to progress eccentric training into the future, providing further knowledge to complement the research developed by Suchomel et al. (37,38). Therefore, this review aims to create a new theoretical framework that defines the different eccentric motions and to determine the optimal exercises and training techniques that can be integrated into S&C practice.

Eccentric: A muscle action or a phase of an exercise?

Eccentric muscle lengthening under tension was originally referred to as a lengthening contraction (7). However, contraction typically describes something getting smaller, which is not the case when referring to eccentric muscle “actions”. Therefore, the word action must be

used rather than contraction when discussing eccentric muscle lengthening. The term "eccentric" is regularly used to describe a muscle action (12), the downward phase of an exercise (26) and targeted training techniques (10,30) among S&C and sports science practitioners. Eccentric muscle actions and associated training techniques are becoming increasingly open to interpretation; subsequently, it is now an umbrella term encompassing various training techniques (17). This causes confusion and offers no clarity regarding training and intended adaptations. Although both are correct alone, the problem with using a muscle action and a phase of an exercise interchangeably is that they are not necessarily connected. For example, although an athlete may perform the eccentric phase of an exercise, it may not definitively represent a 'typical' eccentric muscle action or even an eccentric action is happening (see the eccentric muscle action section below for more detail). This can be highlighted during the downward motion of a countermovement (CMJ). Initially, an individual performs the unweighing phase where negative displacement and muscle lengthening occur (26). However, during this phase, no active (eccentric) muscle action occurs to decelerate the center of mass (26). Nevertheless, by defining this as an exercise's eccentric phase (braking phase), one may assume that active eccentric muscle lengthening is occurring. It must also be noted that McMahon et al. (26) did not refer to the unweighing phase as the eccentric phase.

Alternative terms to define the eccentric phase include the yielding (24,25), braking, absorption, and downward phase. Furthermore, Harry et al. (21) proposed the incorporation of an unloading phase (negative displacement via gravitational pull) followed by two eccentric phases of a *yielding* (positive rate of force development, but the individual still displaces negatively) and a *braking phase* (which determines when a person aims to decelerate themselves) (23). Lindstedt et al. (25) referred to the term shock absorber (i.e., damper) in relation to a spring model. While these may be valid, specific terminology would better describe variations in eccentric motions rather than trying to define them around mechanical

models. Therefore, an exercise's eccentric muscle actions and eccentric phases should be recognized as separate entities. The following sections aim to clarify eccentric motions whereby a downward phase of an exercise is completed and training techniques associated with them.

Eccentric motions: A conceptual framework

Eccentric muscle actions occur when an external force exceeds that produced by the muscle and the muscle is forcibly lengthened under tension (pure eccentric) (29,45). They have also been referenced as a muscular contraction occurring while the muscle is simultaneously lengthening (6). The traditional view of this definition implies that the muscle cannot stop any external force until either the force is released or a joint reaches full extension. However, this disregards any eccentric muscle action where the athlete can decelerate and stop the external force from forcibly lengthening the muscle. This still notes that a muscle lengthens under tension; however, the end outcome of the muscle action differs from that of pure eccentric action. This could also be a factor in other physiological occurrences, such as tendon lengthening.

A construct developed by Franchi and Maffiuletti (13) comments that eccentric training methods should be subcategorized into isokinetic (constant velocity), isoweight (constant mass), and isoinertial (inertia) (17). This construct does provide clarity between different methods to categorize them. However, methods such as AEL and tempo training would fall into the same category of isoweight, yet they are different in their execution and intended physiological adaptations. Recently, Harris-Love et al. (20) created an eccentric model whereby eccentric actions are subcategorized into two groups: recovery of kinetic energy and movements that aim to potentiate force production during ballistic SSC tasks with a focus on maximal acceleration and minimal ground contact time. The other eccentric action is

absorption of kinetic energy, defined as activities that aim to decelerate the angular joint velocity during non-ballistic movements resulting in eccentric force production and dissipating the absorbed kinetic energy as heat.

Further, their review (20) clearly distinguished varying eccentric muscle actions for the first time that should be utilized to define different eccentric muscle actions. However, one limitation of this model is that it does not consider coaching cues or different eccentric training methods for different eccentric muscle actions. Therefore, it seems logical to clarify these specific outcomes as eccentric motion and the training methods that utilize or cause them. It is recommended that the following definitions are incorporated within research and practice for clarity regarding training techniques and adaptations that various eccentric actions complete.

Maximal eccentrics

Definition: From the initiation of the eccentric phase to the end of the eccentric phase, a person cannot decelerate and stop displacing negatively. The end of the eccentric phase coincides with either the exercise end range of movement or when an external mass is unloaded, and they can then complete the deceleration of their new mass.

This example can be noted when viewing exercises such as Nordic curls or AEL supramaximal back squats where there is a clear initiation; however, when the individual is at the end of the eccentric phase, they are unable to decelerate to stop the motion. These types of training methods (Figure 1 and 2 and Table 1) would be incorporated if coaches wish to implement large eccentric forces upon their athletes to increase peak eccentric force capabilities or during the off-season period; these methods can be used to increase muscle mass (37).

Overcoming eccentrics

From the initiation of the eccentric phase, the individual can decelerate and stop the negative displacement of the body and/or external mass and reverse the body and/or external mass for the upward phase. There is no intention to perform the amortization phase as minimally as possible. However, it should also be noted that if the amortization phase is too long, there is no doubt that it may not contribute to the SSC at all (i.e., stored elastic energy).

It is important to clarify that research into SSC action denotes that the amortization phase should be as minimal as possible and though arbitrary values during SSC tasks do exist, such as <250 ms ground contact time for fast SSC (40), there is no research to suggest to what duration the amortization phase can last for before performance is hindered. Therefore, this coaching cue can be used, though it should be noted that no specific duration currently exists. Komi (46) has suggested an amortization phase of <0.9 s for optimal performance; however, again, this is in line with a ground contact time duration. Baker et al. (1) defined the amortization phase as the duration to travel 1 cm on either side of the lowest countermovement position during a CMJ.

Overcoming eccentric motions describes paired eccentric and concentric actions consisting of training methods such as eccentric tempo training and flywheel training (Figure 2 and Table 1).

Rebound eccentrics

Definition: From the initiation of the eccentric phase, the individual can decelerate and stop the negative displacement of body and/or external mass and reverse the body and/or external mass for the upward phase. However, this is performed as rapidly as possible and consists of an SSC task where the eccentric action subsequently enhances the proceeding concentric action. This is performed during tasks such as drop jumps and ballistic-based movements.

During SSC tasks, the eccentric action (stretch) will occur to have a minimal amortization phase; this can enhance the concentric action. The enhancement in concentric performance is theorized to occur from the following but not one has been asserted to be the true cause; greater preload at the beginning of the concentric phase, interaction effects between the contractile and elastic elements, contractile elements in a potentiated state, elastic energy is stored and subsequently utilized and activating the stretch reflexes (5) Rebound eccentric actions incorporate this occurrence, i.e., jumping based exercise such as bounding and drop jumps. Furthermore, as previously noted in the overcoming eccentrics section, the SSC response will be lost if the amortization phase is too long. So a depth jump which dictates a greater displacement upon landing and generally a longer ground contact time compared to a drop jump which is more of a rebound action, SSC response may diminish (41,42).

Dissipating eccentrics

Definition: The eccentric phase begins after an initial impact from a catch or land. A body and/or external mass is then displacing negatively, with the end of the eccentric phase occurring once the body and/or external mass has decelerated and stopped displacing. However, there is no desire to decelerate the body and/or external object as quickly as possible (Table 1).

Dissipating eccentrics suggest a large eccentric force; however, over a set displacement of the eccentric phase, the mass in motion is decelerated and eventually stopped. As during this motion, the muscle force produced attempts to decelerate the mass in motion, it will eventually stop the object as the mass is not changing; this asserts a soft landing technique suggesting larger negative displacement upon landing (2,3). An example of this motion is during a depth land, where a person will perform flexion at the knee and hip joints and achieve a soft-landing strategy where negative displacement is not restricted.

Deceleration eccentrics

Definition: After an initial impact from a catch or land, the initiation of the eccentric phase occurs, and a body and/or external mass is then displaced negatively, with the end of the eccentric phase occurring once the body and or external mass has decelerated and stopped displacing. However, there is a desire to decelerate the body and/or external object as quickly as possible (Table 1).

This motion is like the dissipating eccentric action. However, the distinction between the two is that during deceleration eccentric actions, the aim is to decelerate and stop as quickly as possible, unlike dissipating eccentric actions, where the aim is to decelerate over a larger displacement. As the muscle force produced attempts to decelerate the mass in motion during this motion, it will eventually stop the object as the mass is not changing. This can be seen in hard landing techniques (minimal negative displacement upon landing) (2,3). An example of this motion is a depth landing; however, upon landing, a person aims to achieve minimal knee and hip flexion, asserting a hard landing strategy.

****INSERT FIGURE 1 HERE****

Figure 1 indicates eccentric motions that can occur during resistance-based training. The blue boxes in Figure 1 are centered around impacts (i.e., whereby an impact occurs to a system such as a land during landing tasks and a catch in a bench press throw) and are therefore grouped. Dissipating and deceleration eccentric motions differ by the intended impulse strategy, whereby decelerating eccentric motions attempt to apply a large braking force over a minimal time duration (highly impulsive). In contrast, dissipating eccentric motions instruct individuals to apply a braking force over any duration they deem to be able to decelerate the mass to a stop. It should be noted that the same exercise can fall into the categories of dissipating and deceleration eccentric motions; however, what separates these are the instructions given and, thus, how the exercise is executed. Overcoming eccentric motions (green boxes) can be categorized into the majority of isoinertial exercises, whereby an eccentric-concentric coupling exercise occurs. Rebound eccentric motions (red boxes) relate to eccentric-concentric coupling SSC tasks where the aim is to perform the amortization phase as quickly as possible to enhance the subsequent concentric phase. Maximal eccentric motions (orange boxes) adhere to motions where one cannot decelerate to a stop at the end of the eccentric phase (lowest displacement of the exercise).

****INSERT FIGURE 2 HERE****

Eccentric training methods

Eccentric tempo training

Recent evidence suggests that tempo training is the most frequently used eccentric training technique among S&C practitioners, sports scientists, and coaches (6,9). This is likely because it requires no additional equipment and is easy to implement. In practice, tempo training involves the eccentric, isometrics, and concentric phases of an exercise being performed within a prescribed timeframe (2/0/2/0 eccentric/isometric/concentric/isometric). In acute and longitudinal investigations, the terms ‘fast’ and ‘slow’ have been used to further clarify the intended exercise performance (Table 1). However, as noted by Handford et al. (16) and Cronin et al. (7), the terms ‘fast’ and ‘slow’ are subjective and do not provide clarity as they ignore the use of specific temporal ranges rather than using specific values instead of these terms. Hence, specific timeframes should be applied. Eccentric tempo training techniques have been implemented to increase measures such as strength and hypertrophy among participants (16), with the addition of being an effective tool to help teach correct movement techniques during lifting. For an in-depth review of tempo and eccentric tempo training, please refer to Krzysztofik et al. (24).

Shock method / plyometric training

The shock method (Figure 3) was first mentioned by Verkhoshansky (42) and is widely known today as plyometric training (41,42). This method typically involves jumping-based actions in which a landing or rebound occurs (i.e., the shock) (Table 1). It is important to note that an eccentric action will likely occur during landing tasks as the purpose is to decelerate the body in motion. If an individual falls from a greater height, their acceleration and landing force (to decelerate the individual) will be greater. The implementation of this training method is to improve landing capabilities, such as accentuation of landing forces and SSC response (42). Please refer to Verkhoshansky (42) for more information on the shock method.

****INSERT FIGURE 3 HERE****

Accentuated eccentric loading and accelerated eccentric loading

Both AEL (Figure 4) and accelerated eccentric loading (ACEL) consist of training methods where an external load (i.e., weight releasers or resistance bands) are released at the end of the eccentric phase (15,37,38,43,44). Eccentric-concentric coupling actions (i.e., squat) are used where additional mass or resistance bands aim to overload the eccentric muscle action from an increase in mass and/or acceleration, respectively (27). It is important to remember that the AEL and ACEL stimulus should not interfere with the harmonic motion of the given exercise (27) (Table 1). During such methods, eccentric muscle actions can be trained more effectively. This is because there is an increased mass during the eccentric phase. Therefore, eccentric, and concentric muscle actions are performed maximally, often leading to enhanced force and velocity outputs during the concentric phase (8,27). Loads of 100-150% of concentric one repetition maximum (1RM) can be employed during the downward phase of AEL exercise (28,43). Following the end of the eccentric phase, the external load is reduced to <100% of concentric 1RM (27). Current research highlights the use of supramax AEL as a method to promote muscle and strength over that of isoinertial loaded exercises. However, it is of key importance that submax AEL may not yield similar results (Table 1 and Figure 2). For an in-depth review of AEL, please refer to both Wagle et al. (43) and Moore et al. (31). In addition,

it is important to note that during supramaximal AEL (J Hook back squat as an example), during the initial lowering phase (top to half-squat position) due to mechanical advantage, individuals are stronger during this portion of an exercise (14,39). Because of this, the supramaximal concentric loads may not yield an eccentric overload during this portion of the lift.

****INSERT FIGURE 4 HERE****

Accelerated eccentrics

Verkhoshansky and Siff (41) comment on implementing "accelerated powermetrics motions during training. They termed this 'accelerated eccentrics' and subcategorized it into two groups. *Passively accelerated eccentrics*: whereby either resistance bands (overspeed eccentrics) (35) are incorporated, or an external partner pushes the barbell (a method of a forced repetition). The aim is to facilitate negative acceleration, and when the desired displacement is achieved, the athlete decelerates the bar and completes the concentric phase. Alternatively, during *actively accelerated eccentrics*, the individual performs a drop catch (Figure 5) or pulls the bar down as fast as possible. We propose resurrecting the term accelerated eccentrics as it refers to actively performing the eccentric phase as quickly as possible (16). Accelerated eccentrics is defined as eccentric actions performed at increased velocities with the addition of specific verbal cues, such as letting a barbell free fall and then catching it prior to the end of the eccentric phase (drop catch) (16) (Table 1 and Figure 2).

****INSERT FIGURE 5 HERE****

Plyo-accentuated eccentric loading

Plyo-accentuated eccentric loading (Plyo-AEL) refers to using AEL strategies during jump-based exercise (Figure 6). During this method, the external eccentric stimulus is there to acutely enhance the subsequent concentric action metrics, e.g., force and jump height (15,31,32,34,43,44). This typically involves using an external stimulus such as dumbbells or specialized equipment, including weight releasers (8,15,16,20,27). After completing the eccentric phase, the external stimulus is released to begin the concentric phase. For an in-depth review of this topic, please refer to Handford et al. (15) (Table 1 and Figure 2).

****INSERT FIGURE 6 HERE****

Negatives / eccentric only training

Negatives or eccentric-only training consists of motions where only the eccentric portion of the exercise is completed. The concentric phase is either not completed, or the external load is assisted back to the original position at the beginning of the eccentric phase, and this process is repeated (Table 1). This is either performed by the individual performing the exercise, or a spotter helps. This exercise will usually be completed to maximal eccentric muscle action capacity, utilizing exercises such as Nordic curls or eccentric-only squats (Table 1 and Figure 2).

Isokinetic dynamometry

Eccentric isokinetic dynamometry (IKD) training consists of utilizing specialized equipment whereby a mechanical lever rotates a certain distance while the individual resists its movement. Movement begins with slight acceleration, after which torque remains constant (41) (Table 1). The problem with this training method is that isokinetic devices are not widely available within S&C practice largely due to their cost (Table 1 and Figure 2). For an in-depth review of eccentric IKD methods, please refer to Kellis and Baltzopoulos (22).

2-1 method

This training technique involves an individual completing the concentric phase of an exercise with two limbs. Upon reaching the desired end of this phase, a person will then transition to only completing the eccentric phase with one limb (29) (Table 1 and Figure 7). This training method follows a similar suit to supramaximal AEL; however, instead of the increased mass being reduced at the end of the eccentric phase, the second limb is incorporated to perform the concentric phase. For example, one could perform the seated row with one arm during the lowering phase and then perform the concentric phase with both arms. After completing the

concentric phase, the same process would be repeated, ensuring both limbs complete the same volume (Figure 7).

****INSERT FIGURE 7 HERE****

Flywheel training

Flywheel training uses a flywheel device, where the concentric effort dictates the eccentric resistance. However, one important note with flywheel training, denoted by Suchomel et al. (37), is that eccentric overload is unlikely to be achieved because the concentric impulse dictates the eccentric impulse. One would never achieve an overload as eccentric forces have been shown to exceed that of concentric values. (Table 1 and Figure 2) (33). Though, this training method has been shown to have greater increases in strength and hypertrophy than that of isoinertial based exercises.

Outside the remit of this review, there are various other classified eccentric methods, including the antagonistic facilitation specialized method created with Triphasic Training (8), eccentric isometrics, quasi-isometrics, weightlifting catching derivatives have been associated with absorption qualities (36), and tantrums. An issue that is wider than this review is that there needs to be a set classification of what is defined as an eccentric training method. This is likely related to an exaggeration of the eccentric phase of an exercise that aims to manipulate the mass, velocity, or phase execution. We propose Figure 2 as a working theoretical framework.

This provides practical applications for practitioners to determine specific training effects that certain eccentric training methods will likely elicit depending on their classification, i.e., increases in muscle mass, maximal eccentrics, or overcoming eccentrics.

Furthermore, Table 2 provides a working example of how these methods might be programmed. Figure 2 and Table 1 further identify various training methods that would apply to all coaches depending upon available equipment, i.e., overcoming eccentrics showing, flywheel training, and tempo training. In addition to the current review, Suchomel et al. (37,38), Bridgeman et al. (4), Douglas (9), and Mike et al.(30) all provide further comprehensive views on eccentric training as a whole and how it can be utilized within training. Combined with the reviews above and the current review, academics and coaches can use the knowledge of eccentric training that can be incorporated within a practice to implement eccentric training methods when required.

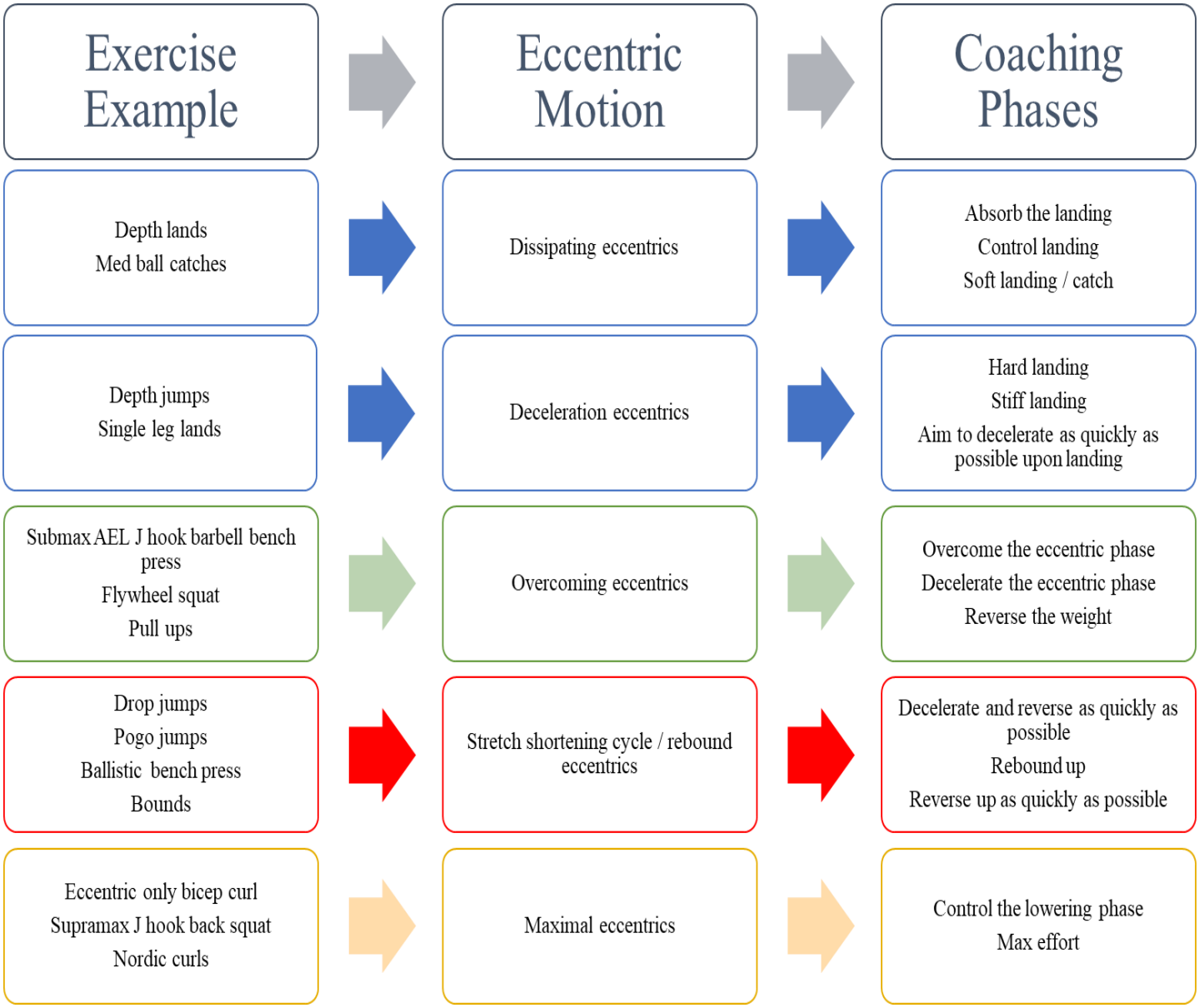
****INSERT TABLE 1 HERE****

PRACTICAL APPLICATIONS

A wide variety of training techniques focus on the unique characteristics of eccentric muscle actions. Researchers and practitioners should not use the phase of an exercise and a muscle action interchangeably to describe an eccentric action. Although one may be occurring, it does not suggest that the other is happening. Nevertheless, many training methods that utilize an eccentric muscle action to gain acute or chronic adaptions are not achieved when applied to other methods. This review does not seek to determine a superior method or provide greater insights into these methods. Instead, it aims to clarify eccentric muscle actions and training techniques. The eccentric motions proposed in this article should guide coaches and academics about the desired eccentric motion they wish to implement, which will facilitate the desired training effect. The terms proposed here need not replace the current terminology used in practice. Still, they could provide a theoretical baseline to allow the accurate deconstruction of the eccentric phase, enabling the identification and prescription of exercises for specific training adaptations (Table 2).

****INSERT TABLE 2 HERE****

434 **Figure Legend**



435

436 Figure 1: A theoretical framework of the various forms of proposed eccentric motions and the
437 subsequent coaching cues and exercises that form the eccentric motions. Key: **Submax**:
438 Submaximal, **Supramax**: Supramaximal, **AEL:** Accentuated eccentric loadi

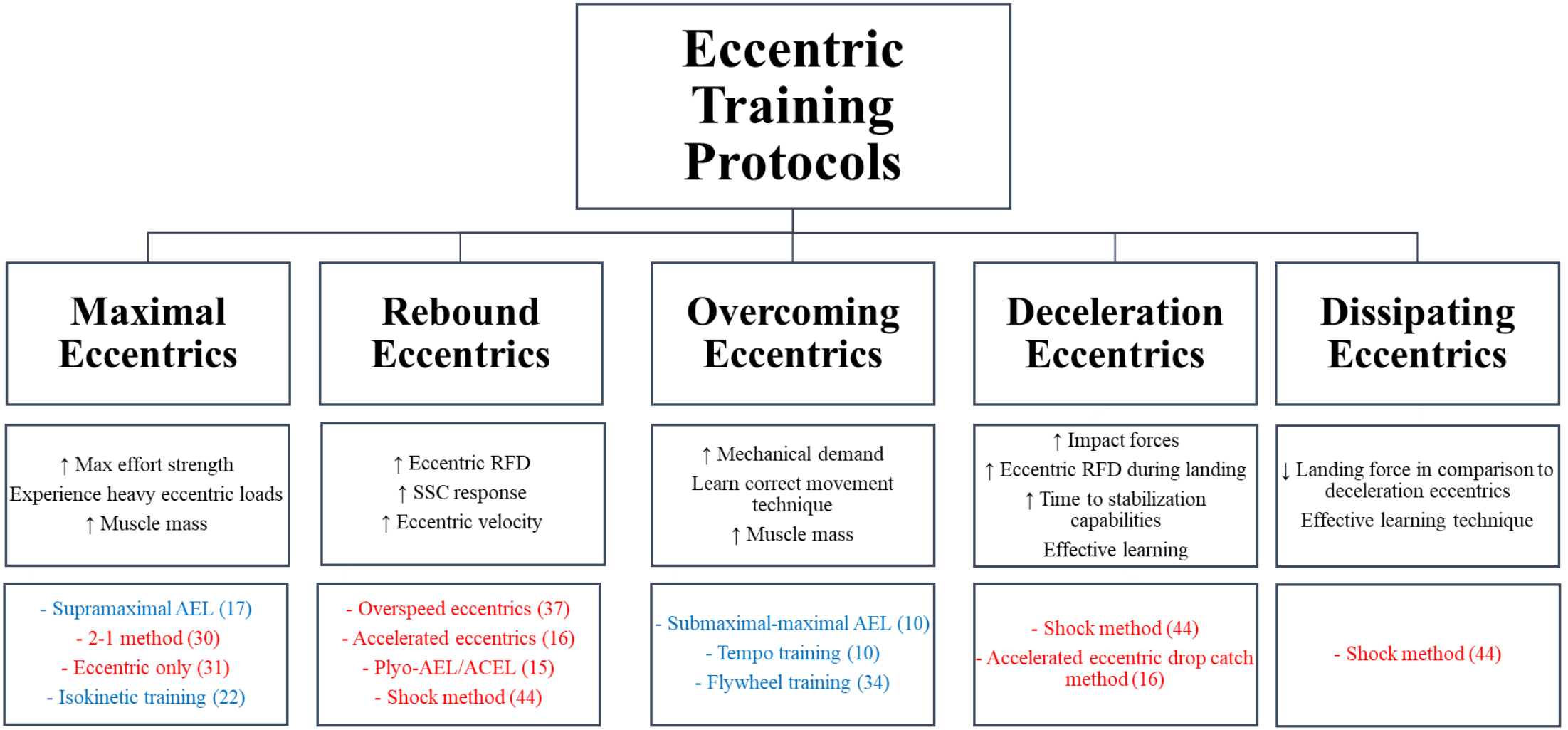


Figure 2: Provides a practical application example of how the eccentric motions can achieve specific desired results. This allows coaches to identify specific training adaptations easily they are looking for and then can implement them into practice depending on equipment and other variables

such as stage of season. The blue text refers to studied peer-reviewed training methods responses; the red text refers to theoretical training method responses. Key: **RFD:** Rate of force development, **AEL:** Accentuated eccentric loading, **ACEL:** Accelerated eccentric loading, **SSC:** Stretch-shortening cycle.

Figure 3: A drop jump as an example of the shock method. A: Standing on platform, B: Stepping off platform, C: Ground contact (impact), D: Flight phase.

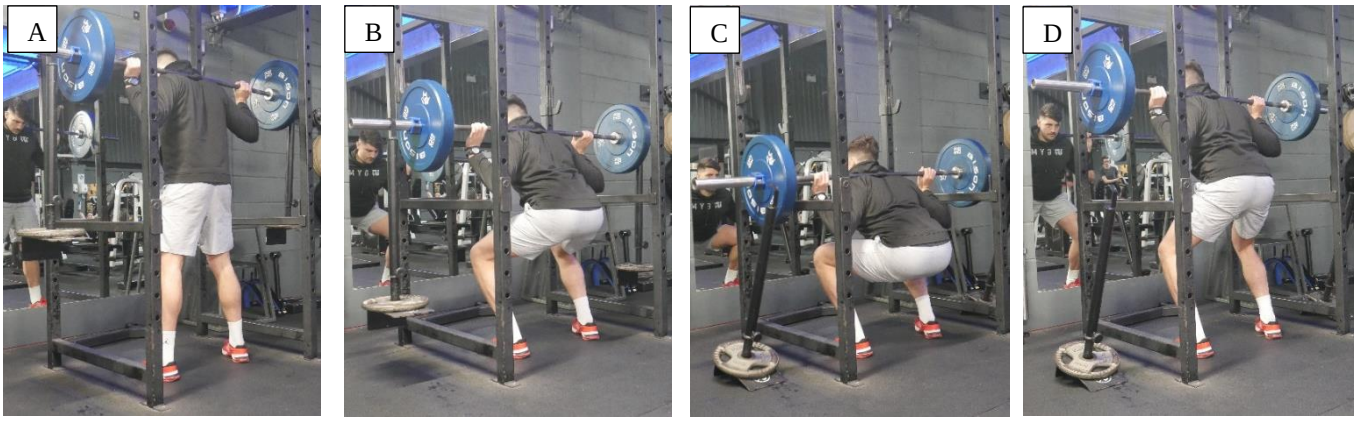


Figure 4: Example of a J hook barbell back squat (AEL). A: Isometric phase (lockout), B: Downward phase (eccentric), C: Bottom phase (isometric) D: Upward phase (concentric).

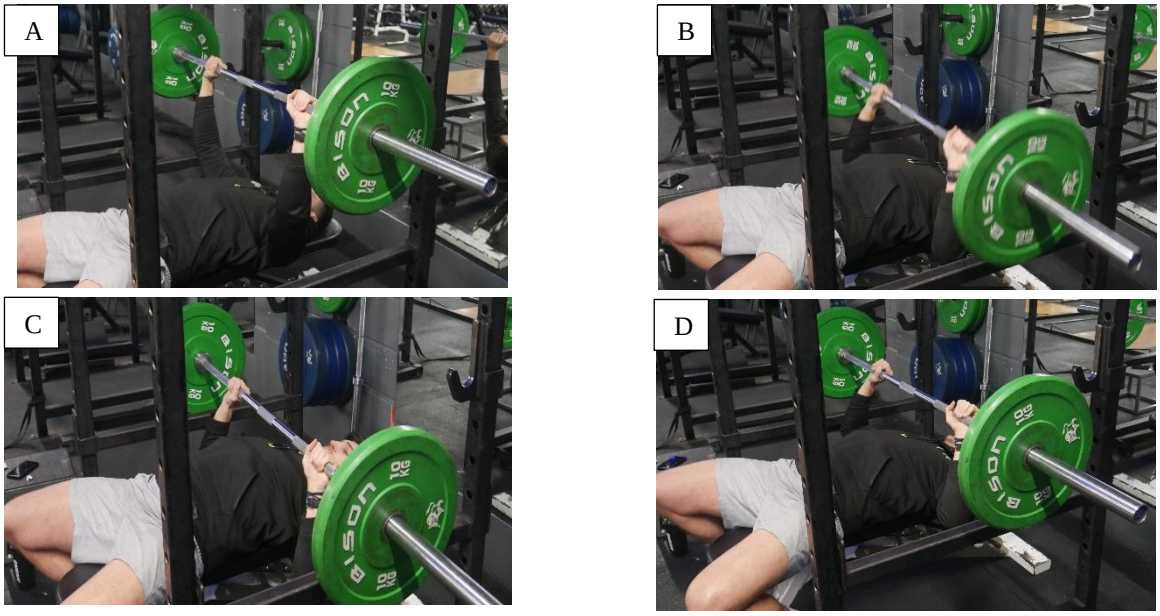


Figure 5: Example of an accelerated eccentric drop catch method during a bench press exercise. A: Lockout (isometric), B: downward drop (eccentric) C: Catch (bottom position), D: Upward motion (concentric).

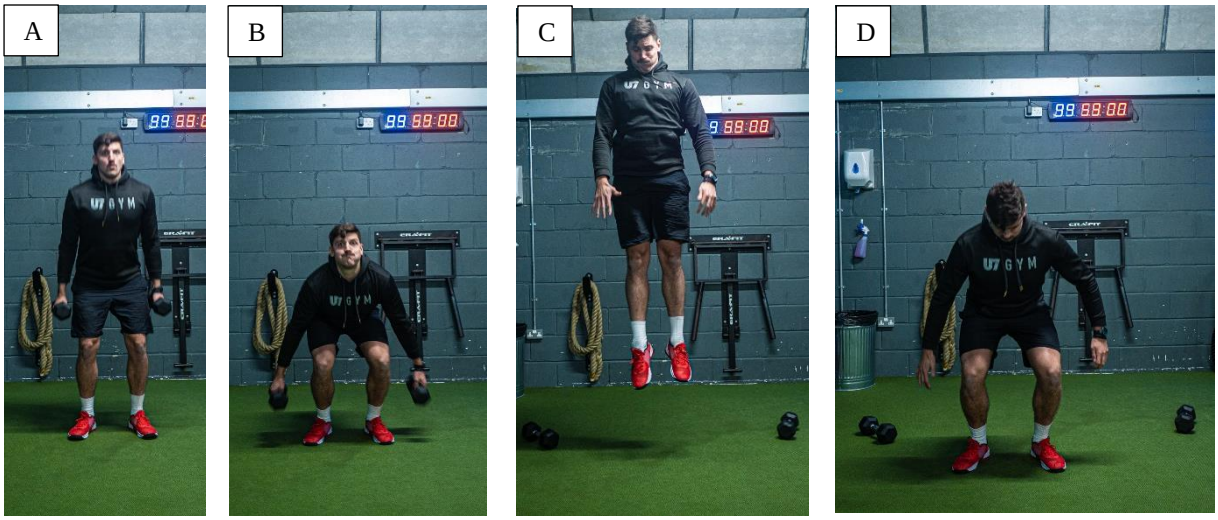


Figure 6: Example of Plyo-AEL dumbbell release method. A: Lockout phase (isometric), B: Braking phase (prior to dumbbell release), C: Flight phase (after release of dumbbell), D: Landing phase.

Figure 7: 2-1 method example during a seated row exercise showing the transition from two to one limb during each phase of the exercise. A: Starting position, two hands (isometric), B: Concentric motion (two hands), C: Isometric hold (release of two to one hand), D: Lowering phase, one hand (eccentric motion).

519 **Table Legend**

520 Table 1: A detailed list of different eccentric training methods and which category of specific
521 eccentric motions they fall into. Physiological adaptions have been amended from Suchomel

Training method	Specialized equipment	Eccentric motions	Physiological adaptions
Supramaximal Accentuated Eccentric Loading (> 100% of CON 1RM)	Weight releasors or specialized equipment	Maximal eccentrics	Strength +++++ Hypertrophy +++ Power Output ++++
Submaximal Accentuated Eccentric Loading (< 100% of CON 1RM)	Weight releasors or specialized equipment	Overcoming eccentrics and SSC/ Rebound eccentrics	Strength +++ Hypertrophy +++ Power Output +++
Flywheel training	Flywheel training device	Overcoming eccentrics and SSC/ Rebound eccentrics	Strength ++ Hypertrophy +++ Power output ++
Tempo training	No specialized equipment needed	Overcoming eccentrics	Strength + Hypertrophy ++ Power output +
Negatives (eccentric only)	No specialized equipment needed or isokinetic dynamometer	Maximal eccentrics	Strength ++++ Hypertrophy +++ Power Output +
Accelerated eccentric loading	Resistance bands	Overcoming eccentrics and SSC / Rebound eccentric	Strength ++ Hypertrophy + Power output ++++
Accelerated eccentrics	No specialized equipment needed	Overcoming eccentrics and SSC / Rebound eccentric	Strength ++ Hypertrophy + Power output ++++
Overspeed eccentrics	Resistance bands	Overcoming eccentrics and SSC / Rebound eccentric	Strength +++ Hypertrophy + Power output ++++
Shock method	No specialized equipment needed	Dissipating eccentrics, Deceleration eccentrics, SSC / Rebound eccentrics	Strength ++ Hypertrophy + Power output ++++
2-1 method	No specialized equipment needed	Maximal eccentrics	Strength +++ Hypertrophy +++ Power Output +

522 et al. (37), who provided a theoretical perspective. + = low potential; +++ = moderate potential;
523 +++++ = high potential.

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Table 2: Shows a working program example of how the proposed eccentric model would aid in enhancing specific areas of physical performance during two scenarios.

Scenario 1: An athlete during an in-season programme, needs to increase eccentric rate of force development and ability to decelerate quickly (lower body example).				
Exercise	Set x repetition scheme	Load	Velocity range if possible or coaching cues	Eccentric motion
Depth lands	4 x 4	Height: 60 cm box	Hard landing	Deceleration eccentrics
Overspeed eccentric back squat	7 x 3 Cluster sets 45 s rest between sets	40% Load and 25% Band Tension of 1RM	0.80-1.00 $m \cdot s^{-1}$	Rebound eccentrics
Nordic curls	3 x 2	BW	Resist downward motion	Maximal eccentrics
Scenario 2: An athlete during the off-season programme aiming to increase hypertrophy and peak eccentric forces (upper body example).				
Exercise	Set x repetition scheme	Load	Velocity range if possible or coaching cues	Eccentric motion
Supramaximal accentuated eccentric loading bench press	5 x 3 AEL cluster set (1 rep AEL 2 reps CON)	110% ECC of 1RM 80% CON	Normal squat motion, push off as quickly as possible	Maximal eccentrics
Pull ups	3 x fail	BW	Tempo 2/1/1/1 (Starting from top position)	Overcoming eccentrics
Dumbbell shoulder press	4 x 10	75-80% of 1RM	Tempo 2/1/1/1 (Starting from top position)	Overcoming eccentrics

Key: **1RM:** 1 repetition maximum, **BW:** bodyweight **CON:** concentric, **ECC:** eccentric, **S:** seconds, **CM:** centimetres, **$m \cdot s^{-1}$:** meters per second. **Tempo:** eccentric/isometric/concentric/isometric.

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