In the evidence-based guide on rest intervals, I discussed how short rest intervals (like 1 minute) usually result in less hypertrophy compared to long rest intervals (like 3 minutes). However, on the other hand, I have reviewed studies showing how drop sets can be a time-efficient method for training for hypertrophy as compared to traditional sets. I have also reviewed research showing a hypertrophiuc benefit of rest-pause sets to failure (i.e., a set to failure followed by "mini"-sets to failure with 20 seconds rest) compared to regular sets with longer rest performed well short of failure. Drop sets and rest-pause sets are essentially successive sets with little or no rest. If short rest intervals tend to be worse for hypertrophy, why is it that drop sets and rest-pause sets don't show this disadvantage?

Key Takeaways

- **Central fatigue is likely the main mechanism behind why short rest intervals tend to produce less hypertrophy. Central fatigue reduces muscle activation.**
- **While drop set training is essentially "no rest" training, most studies on it have utilized isolation movements, which don't produce as much central fatigue as compound movements.**
- **All studies showing reduced hypertrophy with short rests have utilized compound movements, which produce more central fatigue than isolation movements.**

Practical Application

- **When training with compound movements, focus on longer rest intervals (>2 minutes)**
- **Limit short rest, drop set, and rest pause training to isolation movements**
- **If you use short rest intervals with compound movements, you can compensate for reduced muscle activation by doing more sets. You can also gradually decrease the rest intervals over time to allow yourself to adapt to the shorter rests.**
- **When utilizing drop set or rest-pause training, limit the overall amount in a single session.**

Why Do Short Rest Intervals Generally Produce Less Hypertrophy?

Research has shown that short rests of 1 minute result in about half the muscle protein synthesis response to training as that of 3 minutes. However, this still brings up the question as to why there is a lower protein synthesis response with short rest training. While short rests result in lower load volumes for the same number of sets and rep ranges, this is an unlikely explanation. In this study, load volume was only 13% lower with short rests, but muscle protein synthesis was cut in half. It is doubtful that this reduction in load volume would result in such a drastic reduction in muscle protein synthesis. Also, drop sets can result in less load volume than regular sets, yet have been shown to be equally effective for hypertrophy.

The Process of Hypertrophy

To try to understand why short rests might impair hypertrophy, we must first discuss how hypertrophy of an entire muscle occurs. Muscles grow when individual muscle fibers are subjected to tension overload for a sufficient period of time. To do this, those fibers need to be recruited to move the weight. During activities of daily living, the force requirements are low, and thus you don't need a large number of fibers to do the job. However, when the load increases, you have to start recruiting more muscle fibers. With high loads, you recruit muscle fibers that are controlled by high threshold motor units. These fibers are only recruited during high force activities. It is these fibers that have the greatest capacity for growth. This is why activities of daily living don't cause significant hypertrophy...they don't involve the high threshold motor units. However, when you lift heavy weights in the gym, you recruit these high threshold motor units. You place these muscle fibers under high tension for a sufficient period of time, and cause them to grow in size.

High loads are not the only way to increase muscle fiber recruitment. Fatigue is also a way to increase recruitment. This is why lifting light weights to failure is also effective for hypertrophy. Early in the set, the weight is light, and you don't need to recruit the high threshold motor units to move the weight. However, as you continue and fatigue starts to build, you have to start recruiting the higher threshold motor units to continue to move the weight. As you get close to failure, you are now recruiting the fibers that have the greatest capacity for hypertrophy. These fibers don't know that the weight is light...they only know they've been called upon to produce tension. This is also how blood flow restriction (BFR) training works. It creates fatigue very early with light weights, and essentially creates a similar environment to if you were to do a 30 rep set to failure without BFR. You end up recruiting the high threshold motor units with BFR even though the weight is very light.

Central vs Peripheral Fatigue

If fatigue increases motor unit and muscle fiber recruitment, wouldn't this mean that short rest training would increase recruitment as it would amplify fatigue? Not necessarily. There are two types of fatigue (discussed in more detail in this excellent article on short rest training by Chris Beardsley): central fatigue, and peripheral fatigue.

Central fatigue is fatigue that occurs in the central nervous system. When central fatigue is high, it can result in less signal going from the brain to the muscle. This would reduce motor unit recruitment, and thus your ability to tap into the high threshold motor units (which have the greatest capacity for growth) would be impaired. This would have the effect of reducing the number of hypertrophic reps you achieve on a set.

Peripheral fatigue is fatigue that occurs in the muscle itself. As mentioned by Chris Beardsley, peripheral fatigue reduces the amount of force each muscle fiber can produce, so that the central nervous system must increase motor unit recruitment to compensate. It is peripheral fatigue that is responsible for the increased motor unit recruitment as you do a light weight to failure. It is peripheral fatigue that allows similar muscle gains between heavy and light weights taken to failure.

Evidence in Favor of Central Fatigue as the Mechanism Behind Lower Hypertrophy With Short Rest Intervals

While short rest intervals would increase peripheral fatigue, which would theoretically enhance motor unit recruitment, it is clear that the data shows that hypertrophy is often lower with short rests. This leaves central fatigue as the primary explanation behind lower hypertrophy with short rests. There are numerous lines of evidence supporting this hypothesis (some of which have been outlined by Chris Beardsley):

- Both peripheral and central fatigue occur during resistance training and are still present up to 30 minutes after a training session.
- Forced repetitions using compound movements leads to more central fatigue than simply training to failure on those movements. Short rest intervals may mimic some of the same fatiguing effects as forced repetitions.
- Aerobic training performed prior to strength training increases central fatigue and reduces strength training performance. The use of short rest intervals would also increase aerobic demand, which would lead to more central fatigue.
- The accumulation of lactate and other metabolites in muscle may increase central

fatigue. The metabolites in the muscle leads to afferent feedback (information sent from the peripheral nerves to the brain), telling the brain to reduce muscle activation. Since short rests increase lactate accumulation, it stands to reason that short rest intervals would increase central fatigue and reduce voluntary muscle activation.
- Central fatigue likely explains why prioritizing a muscle group first in a workout leads to greater growth in that muscle. By the end of a training session, central fatigue is higher, so muscle activation and subsequent growth may be reduced.

Reconciling the Short Rest Data with the Drop Set Data

Certainly, the evidence favors central fatigue as the primary mechanism as to why short rest intervals often lead to less hypertrophy. But wouldn't this mean that drop sets (which are "no rest" sets) should lead to less hypertrophy? Drop sets would theoretically increase central fatigue.

When we look at the research on drop sets, there is a key distinction from the research on short rest intervals. The studies that have shown a benefit to drop sets have involved single joint, isolation movements on small muscle groups. Single joint movements lead to less central fatigue compared to multijoint movements. Also, central nervous system recovery is fairly rapid after single joint movements. Thus, you would not see the same impact of short-rest or no-rest sets on hypertrophy with single joint movements as compared to compound movements. When we look at the research on short rests, the majority of studies that have shown a detrimental effect have involved compound movements or a mixture of compound and isolation movements. In fact, the only study that showed a statistically significant benefit of short rests over long rests involved mostly single joint arm movements.

A couple studies showed no statistically significant impact of short rests on hypertrophy, and these studies involved both compound and isolation movements. However, rest intervals were gradually decreased each week from 2 minutes to 30 seconds by the end of the study. This may have improved the subjects' abilities to tolerate short rest intervals and metabolite accumulation, and thus reduce the impacts of short rests on central fatigue. In support of this, it's been shown that endurance athletes recover faster from central fatigue as compared to strength athletes. Thus, gradually decreasing rest intervals may increase the "endurance" of the central nervous system, and thus the impact of short rest intervals on muscle activation might be reduced.

The following table shows the outcomes of the various short rest and drop set studies, and you can see the pattern of how the impact of short rests is generally only apparent when using compound movements (here I'm defining short rests as anything 90 seconds or less).

Studies Showing Inferior Results with Short Rests	Short Rest Intervals	Type of Movements Utilized	Studies Showing Equivalent or Superior Results with Short Rests	Short Rest Intervals	Type of Movements Utilized
Buresh et al. 2009	1 min	Compound & Isolation	de Souza Jr. et al. 2010	2 min decreasing to 30 seconds by end of study	Compound & Isolation
Schoenfeld et al. 2016	1 min	Mostly Compound	de Souza Jr. et al. 2011	2 min decreasing to 30 seconds by end of study	Compound & Isolation
Schoenfeld et al. 2017	30 sec	Compound	Fink et al. 2017	30 sec	Mostly isolation
McKendry et al. 2016	1 min	Compound & Isolation	Fink et al. 2017	0 sec (drop sets)	Isolation
			Ozaki et al. 2017	0 sec (drop sets)	Isolation

Implications for Program Design

If central fatigue is the primary mechanism behind how short rests tend to result in less hypertrophy, then this has important implications for program design. You want to take steps to reduce central fatigue and minimize its impacts on muscle activation:

- When training with compound movements, focus on longer rest intervals (>2 minutes)
- Limit short rest, drop set, and rest pause training to isolation movements
- If you use short rest intervals with compound movements, you can compensate for reduced muscle activation by doing more sets. You can also gradually decrease the rest intervals over time to allow yourself to adapt to the shorter rests
- When utilizing drop set or rest-pause training, limit the overall amount in a single session. For example, the constant successive sets to failure with very short rests during rest pause training will likely increase central fatigue (similar to forced reps). Thus, the potential benefits of getting the same hypertrophic reps in a shorter period of time with rest-pause or drop sets must be balanced with the increased central fatigue from these techniques. The central fatigue caused by too much use of these techniques might override the motor-unit recruitment enhancement achieved through peripheral fatigue.