Scientific Shooting Secrets
Developing Muscle Memory
Mental understanding is the basis for physical understanding. The brain controls the body.

“Physiologically, the function of the brain is to exert centralized control over the other organs of the body. The brain acts on the rest of the body by generating patterns of muscle activity”
http://en.wikipedia.org/wiki/Brain

It’s important that you understand the HOWS and WHYS before you do anything. You shouldn’t put up any shots until you understand HOW shooting works and HOW your body mechanics affect the flight of the ball.

**DO NOT PRACTICE SHOOTING** at all until you have an understanding of the **physics and mechanics of shooting**.

**DO NOT PRACTICE SHOOTING** at all until you have an understanding of the causes of **shooting related injury** and how to stop them.

**DO NOT PRACTICE SHOOTING** at all until you have an understanding of how **memory encoding** works and **muscle memory** is developed.

Mental understanding lays the foundation for physical understanding. “Efficient Shooting” will help you develop this understanding so that you can use the brain to control your body in an efficient manner- in your shooting mechanics, in your training routines, and later in game situations.

**Mental understanding is the basis for physical understanding.**
Look for % improvements BETWEEN sessions

Sleep Drives Learning

Sleep plays an important part in learning. **Sleep is when memory encoding happens for learning.** So we should look for % improvements between sessions, not during sessions.

“Current studies demonstrate that a healthy sleep produces a significant learning-dependent performance boost[^3][^4]. The idea is that sleep helps the brain to edit its memory, looking for important patterns and extracting overarching rules which could be described as 'the gist', and integrating this with existing memory.[^5] The 'synaptic scaling' hypothesis suggests that sleep plays an important role in regulating learning that has taken place while awake, enabling more efficient and effective storage in the brain, making better use of space and energy.”


Go through your shooting workout to get your makes. Don’t worry about your % in workout. Sleep on it. Encode the memory of the makes. Come back to your next session and look for % improvements.

Before sleep is also a great time to run through your mental rehearsal or review film for imitation learning. **Pre-sleep mental rehearsal can focus your dreams**- specifically on made baskets if that’s what you want. **Watching footage of your makes before sleep** may help you as well. Take advantage of the recency effect by focusing your pre-sleep thoughts on what you want to improve at.

**Sleep is a major driver for learning and sleep** should be a priority, and you may find improvements are slower during periods where you don’t get enough sleep. Do what you can to get enough sleep. It will improve your learning for all things, and this includes shooting.
ALWAYS FINISH ON A MAKE

Take Advantage of Recency Bias

We recall the last item in a series the best. We fixate on the final possession at the end of game and fail to recall possessions in the middle of the game. We can take advantage of this in our training by ALWAYS ENDING ON A MAKE.

“When asked to recall a list of items in any order (free recall), people tend to begin recall with the end of the list, recalling those items best (the recency effect).”


Whatever the last shot, that is the shot we remember. We can hit 9 in a row and miss the last one and that is the one we remember. We can miss 9 in a row and hit the last one and that is the one we remember. It is important that we REMEMBER THE MAKE as that is the form that we internalize when encoding memory.

Since we have control over our last shot it is very important to ALWAYS END ON A MAKE. Never walk away with a miss. If you shoot a shot and miss it, repeat it from that floor spot until you make it. Then you are free to leave with the memory of a make.

You may want to end a sequence with consecutive makes, but what’s most important is ending on AT LEAST ONE MAKE. Ideally that last make is a SWISH.

In your shooting exercise run through a checklist of game shots. Get your make (or consecutive makes) end the sequence, and move on to the next shot. This gives us the memory of the most makes as we have the most end sequences to remember.

If we shoot from the same floor position over and over we may only recall that last shot. The middle shots in the sequence don’t get recalled nearly as well. So shooting the same shot over and over can be a waste of time. Focusing on getting your make, end the sequence, and start a new one.

It is very important to ALWAYS END ON A MAKE. Make that last make a SWISH.
Shooters should **ANALYZE THEIR OWN FILM** specifically to take advantage of imitation learning. Imitation learning is a powerful tool for improvement. **WE LEARN BY WATCHING.**

“This is dramatic evidence for the power of imitative learning.”


Automatic imitation describes unconscious imitation learning.

**“Automatic Imitation”** - The term is commonly used to refer to cases in which an individual, having observed a body movement, unintentionally performs a similar body movement or alters the way that a body movement is performed. “

http://en.wikipedia.org/wiki/Mirror_neuron

The physical brain mechanism for this occurs through MIRROR NEURONS. Mirror neurons allow the brain to fire the same both when acting and observing another acting.

“A mirror neuron is a neuron that fires both when an animal acts and when the animal observes the same action performed by another”

http://en.wikipedia.org/wiki/Mirror_neuron

We can take advantage of mirror neuron powered imitation learning both by watching great shooters shoot and watching ourselves shoot.

**Watch great shooters shooters shoot**- it will help us pick up the nuances of their form which will be realized in physical form improvements.

Watching ourselves shoot is a way to further internalize our makes.

**FILM AND ANALYZE YOUR SHOOTING SESSIONS.** You don’t have to film all of them, but you should film some of them. Though you could film all of them, not physically shoot that much, and have great results.
Go through the footage, review the misses to see what you did wrong, and discard them. **Save the makes. Go through the footage of the makes to further internalize them.**

When you watch your reel of made shots your mirror neurons fire exactly the same as when you made them. You learn from watching yourself shoot by imitation learning. Your form improves to contain the best elements of the makes only.

Imitation learning is real and powerful, and shooters should take advantage of it both by watching great shooters shoot and watching themselves shoot makes.
Mental Rehearsal as Physical Physical Rehearsal

Imagination Builds Muscle Memory

Multiple studies have found mental rehearsal improves physical performance. One study found that mental rehearsal for free throw shooting improved free throw shooting %.

“this investigation found equivocal results for the efficacy of an imagery protocol for the free throw shot”

“The present investigation was able to replicate Shambrook and Bull’s (1996) results with respect to the efficacy of the intervention; both studies found the use of imagery to be effective for some subjects.”

We can think of mental shots as having a similar learning value to physical shots. This is an extremely powerful and time saving tool that can be used in many ways.

We can put up shots to or from work or school. We can put up shots in our head from anywhere. And these mental shots have a similar performance boosting effect to physical shots.

We can put up mental shots as a substitute for physical shots at times when we’re unable to get to the court with NO INJURY RISK. Mental shots are a tool to improve shooting while minimizing repetitive movement related injuries.

Shooters should make as much use of mental rehearsal as possible- always imagining in vivid detail the shooting motion from start to finish with a made basket- from as many varieties of game shooting situations as possible.

Shooters should imagine defense and game clock situations. Shooters should imagine the details of crowd noise to prepare for games.

“That’s why when you practice the free throw you should always have the mental thought of a game so that when the time comes within a game you relax and everything comes to you very easily.”

Shooters should mentally rehearse shooting with BOTH SIDES OF THE BODY to develop symmetrical muscle memory for developing a symmetrical body.

Shooters can make use of mental rehearsal in games as well. A great time to take advantage of this is at the free throw line. Imagine your shooting motion with the ball going into the basket before you shoot.
Important takeaway is that IMAGINATION provides a REAL EFFECT on developing MUSCLE MEMORY. This is an extremely time efficient training technique that shooters should take great advantage of.
Practice Both Sides of Your Body

Build a Symmetrical Body Through Symmetrical Movements

Repetitive movements change the body. Movement is a way to change the size and shape of muscles, which can change how tendons, ligaments, and bones interact in movements.

Repetitive asymmetrical movements build an asymmetrical body. Asymmetrical body will cause performance problems as well as health problems. Scoliosis is an example of movement based body asymmetry.

This study found that asymmetrical exercises made scoliosis worse, and symmetrical exercises made scoliosis better.

“Specific asymmetrical exercises increase EMG amplitudes of paraspinal muscles in the concavity. If confirmed in longitudinal studies measuring improvements of postural deficits, these exercises may advance care of patients with scoliosis.”


To prevent asymmetrical related body issues it is important that shooters PRACTICE BOTH SIDES OF THE BODY.

For maximum body symmetry 50% per side is ideal, but with pressure to specialize that may be difficult.

Shooters should strive for as much symmetry as they can. Aim for a few non-specialized side makes per session, or entirely non-specialized side sessions.

Mental rehearsal should include both sides of the body as mental rehearsal is important for developing muscle memory.

An example of a shooter who is frequently observed practicing both sides shooting is Stephen Curry.
Steph Curry practices both side free throws
https://www.youtube.com/watch?v=1LBWNhfCyaE

Steph Curry practices both side 3s
https://instagram.com/p/kf1DcoN594/

Even if you never use your non-specialized side to shoot free throws in your game it is important for developing body symmetry. But you may find that the ability to shoot with your non-specialized side will be useful at times in game.
The final benefit of practicing with both sides is improved comprehension of physics and body mechanics. You will find that practicing with your non-specialized side improves shooting with your specialized side through greater understanding.

For these reasons it is very important that shooters PRACTICE BOTH SIDES.
Space out Makes over Days
Take advantage of the Spacing Effect

Humans learn better when they study a few times spaced out than when they repeatedly study in a short period of time given the same amount of total sessions / repetition.

“spacing effect is the phenomenon whereby humans more easily remember or learn items when they are studied a few times spaced over a long time span (“spaced presentation”) rather than repeatedly studied in a short span of time (“massed presentation”)”

http://en.wikipedia.org/wiki/Spacing_effect

This study found that taking 56 days between studying was more effective for learning than 28 or 14 days between sessions.

“For all three difficulty rankings of the foreign words, recall was highest for the 56-day interval as opposed to a 28-day or a 14-day interval. Additionally, 13 sessions spaced 56 days apart yielded comparable retention to 26 sessions with a 14-day interval.”


The ramifications for this are HUGE as we learn that we do not need to practice all the time to get very good at something. Time off may even help us IMPROVE.

You don’t need to put up a million reps. Instead take the time to study and learn other things. When you do put up reps get high quality reps with the necessary pre-shooting and post-shooting mental exercises to take full advantage of most effective learning practices.

“...with any considerable number of repetitions a suitable distribution of them over a space of time is decidedly more advantageous than the massing of them at a single time.”

http://psy.ed.asu.edu/~classics/Ebbinghaus/index.htm

Take advantage of the spacing effect by taking time between your sessions. You will learn faster from making 10 shots for 10 consecutive days than 100 shots once every 10 days.

It’s unclear what the best amount of time is between shooting sessions, but breaks of days, weeks, months, or even YEARS off may actually help. Give yourself some off seasons to work on other things and feel good about coming back to what you had before with movement improvements added from other fields of study.
Michael Jordan was known to take off seasons to golf. Jordan even took the entire 1993-1994 NBA season off in “retirement” to play Baseball and returned after 17 months in the 1994-1995 season to his best 3p% ever at 50%.

We frequently see past NBA sharpshooters come out to put on shooting displays, YEARS removed from the game. For example, a retired Reggie Miller-
https://instagram.com/p/0irpu2nNhE/

Take advantage of improved learning by spacing your shooting workouts. Spread them out. Take off seasons. You will learn better this way and have more time in life to focus on other things.
Repetition vs Experimentation

*Rote Learning vs Experiential Learning*

“You can practice shooting eight hours a day, but if your technique is wrong, then all you become is very good at shooting the wrong way.”

-Michael Jordan

Excessive repetition of anything is **known to cause injury**.

*A repetitive strain injury (RSI) is an “injury to the musculoskeletal and nervous systems that may be caused by repetitive tasks, forceful exertions, vibrations, mechanical compression, or sustained or awkward positions.”[1] RSIs are also known as cumulative trauma disorders, repetitive stress injuries, repetitive motion injuries or disorders, musculoskeletal disorders, and occupational or sports overuse syndromes.*


In “Physics and Mechanics of Shooting” we covered some repetitive shooting injuries- knee injuries from knees together shooting, elbow and wrist injury from repetitive hyperextension, knee and ankle injuries from landing. Repetitive inefficient foot striking may cause injury as well.

As a learning technique repetition is known as **“Rote Learning”**.

There is insufficient clinical evidence that learning by repetition, or rote learning, is an effective learning technique compared to alternative learning methods. There is **evidence that learning by repetition is not as effective** compared to alternative learning methods.

*(rote or parrot fashion learning should be replaced by more reliable teaching method)*


As repetition is linked to sports injuries and learning by repetition is found ineffective as a learning style, **learning shooting by repetition is not advisable.**

Experiential learning is supported to be a better learning method. Experiential learning is “learning by doing and reflection on doing” is heavily based on experimentation and contemplation. Experiential learning is based on **REASONING over repetition.**
“experiential learning offers a sound opportunity to improve student retention”

Shooting the same shot over and over again is a good way to get injured. Shooting (and making) a variety of shots and taking the time to reflect on those thoughts is likely a better method for learning improved shooting methods and techniques.

**Start Deep and Move In**

*Practice for Arc and Range*

In “Physics and Mechanics of Shooting” we described accuracy as a function of Release Speed and Release Angles. We further broke this down as accuracy as a function of Arc, Range, and Aim.

In our shooting practice we should specifically control for release speed. Arc and range are extremely important and we need to make sure we have sufficient arc and range for all of our shots.

**Always shoot deep shots in every session. Consider shooting deep shots to start the session to control for arc and range.**

It’s much easier to take release speed off then to add release speed on. Start with maximum release speed shots and take speed off as you move in.

When we start near the basket we control for aim only, and as we move out we may struggle to produce sufficient arc and range. The solution for this is to **start by moving out deep to shoot with sufficient arc and range, then move in.**

Remember when shooting deep shots to **ALWAYS END ON A MAKE.**
Shooting Session as a Checklist for Makes

Develop muscle memory for a WIDE VARIETY of game shots

To take maximum advantage of recency effect on memory we want as many end sequence makes as possible. The more end sequence makes the more makes we will remember, and the more diverse situation of makes.

The more shooting series, the better. Keep the series short with a specific goal. One make, one swish, 2-3 consecutive makes, then move on to the next series.

Each shot should be conceivably a game shot, though use your imagination to define what a “game shot” is.

Take advantage of mental rehearsal to imagine defenders. Imagining defenders is important for translating practice shooting to game shooting.

Don’t worry about shooting % in the workout. Improvements will happen in between sessions. Get your make and move on.

Here are conceivable shooting series you can run in your shooting workout.

Game Shot MAKE Checklist for Shooting Workouts

(Not Comprehensive)

✓ Get a make off game routes, pop outs, zipper cuts, flair screens

✓ Get makes off hop to the left, hop to the right, hop forward, hop back

✓ Get makes off left right 1-2 step, right left 1-2 step, 1-2 step forward, 1-2 step back

✓ Get makes off variety of body rotation

✓ Get makes off foot runners

✓ Get makes with real and imagined defense
✓ Get makes from a variety of floor spots
✓ Get makes from both sides of the floor
✓ Get makes off the catch
✓ Get makes catching on the sides and catching on top and bottom
✓ Get makes off bad passes
✓ Get makes off body contact with a partner
✓ Get makes off the dribble
✓ Get makes both on-seams and off-seas shooting
✓ Get makes ending with 4 limb back landings
✓ Get makes off pump fakes
✓ Get makes off pass fakes
✓ Get makes with extra high arc
✓ Get makes off the backboard
✓ Get makes off footwork combos
✓ Get makes off spins and half spins
✓ Get makes off dribble combos
✓ Get makes with both sides of the body

When we see how many conceivable shooting series there are, with an understanding of recency bias on memory we can see how much time excessive repetition can waste.

Aim for variety. The more series ended on makes the more diverse our memory is of made shots from our shooting workout.

This method uses scientific learning principles to make the most efficient use of our time for developing muscle memory for GAME SHOTS ONLY.
For an idea of how this might work take a look at a 20 minute shooting workout from Steve Nash. Steve Nash is a career 90% free throw shooter, 43% 3 point shooter and 52% 2 point shooter over 18 NBA seasons.

https://www.youtube.com/watch?v=u4nkgCi0UHU

We see that Steve Nash practices a **VARIETY of sequences** and **ALWAYS ENDS ON A MAKE**, usually consecutive makes. He **only spends 20 minutes shooting** and gains a diverse memory of end sequence makes for a variety of game type shots.

Steve Nash’s shooting workout provides a good basis of how to structure a shooting workout. From our understanding of recency bias we could **recommend shooting with even more variety, ending only on one make and not consecutive makes**. But this training method has worked well for Steve Nash.

You may practice the same game shots as Steve or you may practice specific game shots for your skill set, your play style, your team’s offense. The specific game shots you practice are not as important as the training method to **gain muscle memory in the most efficient way possible**.

**Mix up your shooting series between sessions.** Consult your checklist for makes and gain new shooting memory experience every time. **You will always have memory of previous shooting series end makes to draw muscle memory from.** The goal of shooting sessions is not to repeat old shots but to **LEARN NEW SHOTS** every time.
After sessions review your footage of makes to better internalize your memory of makes through imitation learning. Review your makes before going to sleep for maximum memory encoding.

Get high quality sleep between shooting sessions. Come back and look for % improvement in old series or overall % improvement as you try new shooting series. You should get your makes faster in subsequent sessions.

Imagine shooting in GAME SITUATIONS with defenders and clock situations.

Experiment! Don’t do it the same every time. Play around with form and reflect on it. Try out new shots!

This training method does not require 1000s of reps!

You can run through an entire shooting workout IN YOUR MIND with the power of mental imagery and come back to % improvements similar to if you had physically shot them.

Get makes on BOTH SIDES OF YOUR BODY for symmetrical body and improved understanding.

You should not have to spend that much time shooting at all. You should be able to quickly expand your shooting repertoire with minimal time input. You should be able to TAKE TIME OFF and come back to muscle memory with minimal upkeep. Take advantage of Spacing Effect for most effective learning- it’s better to put up a few shots consistently than many shots once in a while.

This method allows you to spend time developing other parts of your game and developing other parts of your life.

Use these scientific learning methods to quickly improve your shooting preparation with minimal time investment.

This method is 100% backed by scientific strategy for developing muscle memory through understanding of how learning happens in the brain.
Bonuses

Practice Shot Preparation

Catching, Collecting, Dribbling

In “Physics and Mechanics of Shooting” we covered how most shooters develop a preference for “on the seams” grip with their fingers aligned along the seams of the ball and their release finger positioned in the middle of the ball.

This on-seams positioning acts as a guide for finger placement - release finger goes to the middle of the seams and the rest of the fingers fall into place. More importantly the on-seams release positioning is also the ideal for perfect vertical back spin to make maximum use of Magnus Force for lift while minimizing side to side curve in the air.

Maximum lift and minimum curve from Magnus Force
Even if a ball is shot with vertical backspin, if it is shot off-seams Magnus Force will give it a slightly curved path sideways.

As a shooter you have likely developed a preference for on-seams grip for on-seams release as well and there are physical advantages to this.

The on-seams release is an extension of on-seams preparation that happens on the catch, the collection, or even off the dribble.

This section covers the details of the grip mechanics and the fastest way to develop the muscle memory for shooting preparation with scientific learning principles.

Many advanced passers will throw on-seams backspin passes. These passes have the same release spin as a jumpshot.

For an on-seams backspin pass if we catch the ball with our shooting hand ON TOP of the ball instead of on the sides we are prepared to release the ball on seams without any adjustment during the shooting dip.
Kawhi Leonard prepares his on seams release by catching with his shooting hand on top

You should deliberately train yourself to catch the seams on top outside of shooting practice.

An extremely fast way to learn catching the seams on top is by lying on your back and shooting / catching on the seams with no adjustment.

Release on the seams. Catch on top / on the seams. Switch hands. Repeat
Not all passers will throw backspin passes. Some passers prefer to throw sidespin passes. To prepare the shooting hand for release the **shooting hand should catch on the SIDE** instead of on top.

*Rafer Alston side-spin pass*

Side-spin passes may be easier for many shooters to catch. Side catches are more natural for many shooters.

*Ray Allen prefers to catch on the sides*

When catching or collecting on-seams on the sides the **non-release hand should be moved out of the way** for the **shooting hand to face the basket**. The mechanism for this is a **index finger pivot** on the non-release hand. The **ball rotates around the non-release index finger pivot** to **face the release finger on seams to the hoop**.
The **index finger pivot happens before or during the dip phase of the shot**. After the pivot the index finger can be moved out of the way before the release- usually between the pull and push or after the push but before the release.

Brandon Knight uses this technique to face his release finger on-seams to his target.

Klay Thompson also uses this technique-
Klay Thompson side catches on seams and pivots to face the shooting hand on-seams to the basket

Klay dribbles on-seams, collects on sides, and faces his release hand to the target for on-seams release

Many passes will be scrambled- they will not be clearly on seams or be passed with mixed spin. We may be forced to catch from a random position. It is possible to pivot to the seams from any catch position in one motion. This pivot can happen during the dip phase of the shot.
Klay Thompson gets to the seams from ANY catch position

Shooter’s should **practice BALL COLLECTION SKILLS SPECIFICALLY**. These skills must be specifically learned, but are easy to learn, and will quickly translate to shooting improvements for on-seams backspin release shots.

**Finger Pivot Drill**
Finger pivot back and forth across the ball. From left hand-on seams to both hands on-seams to right hand on-seams and back across.
https://www.youtube.com/watch?v=9VFLkzuX6-Q

Rubik’s Cube Drill

Catch the ball at random. Pivot to the seam in one move from the catch
https://www.youtube.com/watch?v=R0DEnTKAwBE

When shooting off the dribble we can prepare our on-seams release from the collection and prepare our collection from our dribble. Most NBA guards deliberately dribble on the seams when possible.
Gordon Hayward prepares his shot from his dribble
Rather than dribble on the seams, **some guards prefer to deliberately dribble on the ends.** When dribbling with the non-release hand on the end of the ball it is **easy to collect the ball with the release hand on-seams with the non-release hand already moved out of the way.**

An **extremely fast way to learn** on-seams dribbling and collecting as preparation for on-seams release is by **DRIBBLING IN FRONT OF A MIRROR**

“The **mirror can be an effective tool** in the ballet classroom. It provides several benefits, including allowing a student to evaluate his or her technical growth and the ability to see the activities in the classroom from more perspectives, which can aid in the learning process.”


Dribbling in front of a mirror gives us a **view of the seams of the ball without having to look at the ball.** Through this practice **we quickly learn the technique** for on-seams dribble and collection for shot preparation.

**On-seams dribbles allow on-seams shot or pass off any dribble**
Mirror training is scientifically proven to hasten learning of movements and it’s an amazing tool for learning on-seams dribbling and collecting quickly.

Many gyms contain dance studios that will allow you to dribble in front of mirrors. Take advantage of this. If this is unavailable to you then you can build a small mirror studio in your garage.

This training method is absolutely worth the small amount of time you have to invest for the massive gains in control over the seams of the ball- from the dribble, to the collection, to the on-seams backspin release.

All that said, on-seams is not the end all be all. You will not always have the time or ability to get to the seams and sometimes you have to shoot anyways. You should specifically train to shoot off-seams catch and shoot or you may find your shooting options limited by the quality of passes you receive.
Ray Allen prefers to shoot on-seams but is not limited to it

Shooters have a preference for on-seams release for real reasons- on-seams release with vertical backspin takes maximum advantage of Magnus Force for lift while minimizing side to side drift on the flight path of the ball.

On-seams release is an extension of the catch, the collection, and even the dribble. Learning the mechanics of shooting preparation is EASY but it requires DELIBERATE ATTENTION.

When using these drills to learn shooting preparation use the scientific learning principles outlined in this book-

**Space out your sessions.** Once a week is plenty. Less frequently is fine too. Once you have developed the muscle memory you won’t need much or any upkeep to retain these skills.

**Record your sessions.** Review the footage and cut out the mistakes. Review the “makes” and review them before sleep.

**Mentally rehearse your workouts** in replacement of workouts. Do this at down times, or do it before sleep.

**Imagine** catching, dribbling, and collecting in GAME SITUATIONS with defenders and clock situations.
Experiment! Don’t do it the same every time. Try out new methods and reflect on them.

Practice on BOTH SIDES OF YOUR BODY for symmetrical body and improved understanding.

Use these scientific learning methods with these drills to learn mastery of shooting preparation with minimal time investment.
NEVER SPRAIN YOUR ANKLE LANDING EVER

4 limb back landing technique

You should never, ever sprain your ankle landing from a jump shot EVER. This kind of injury is 100% avoidable.

Don’t let this happen to you

The simple solution to this is to land contested shots with 4 limbs, preferably on your back. Jamal Crawford is very good at this. Crawford is king of the And 1 3 in the NBA and he never sprains his ankle, even when defenders slide under him.
A 4 limb landing spreads impact force across 4 limbs. Twice as many limbs, twice as much muscle involvement. You can come down on a foot and still have 3 other points of solid ground contact.

It is important to PRACTICE BACK LANDING from jump shots. If you don’t do it in practice you won’t do it in game. It’s not necessary to do all the time, but it’s important to be confident in how to do this technique and when to do this in games.
So **practice 4 limb back landings** to avoid ankle sprains. **Ankle sprains are 100% avoidable** with this technique.

Concerns about wrist injury when landing on all 4s? Watch a tutorial on this move here- [https://www.youtube.com/watch?v=Z2fBtkBGYRM](https://www.youtube.com/watch?v=Z2fBtkBGYRM)

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**Prevent Follow Through Injury**

**Deceleration Training**

Repetitive hyperextension of the elbow and wrist joints causing “shooter’s elbow” / “shooter’s wrist” which over time can become arthritis of the elbow and wrist joint.

> “Conclusions: The findings support the theory that repetitive hyperextension to the elbow results in pathological changes.”
> -Hyperextension trauma to the elbow [http://bjsm.bmj.com/content/36/6/452.full](http://bjsm.bmj.com/content/36/6/452.full)

> “A variety of traumatic insults may ultimately result in specific forms of posttraumatic arthritis to the elbow joint.”
> -Primary and Posttraumatic Athritis of the Elbow [http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3678412/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3678412/)

> “The hyperextension loads produced four lesions: (1) anterior capsule rupture; (2) L-shaped rupture of the pronator/flexor origin with elongation of the anterior part of the medial collateral ligament; (3) occasional incomplete rupture of the lateral collateral ligament; and (4) small fragments of cartilage near the posterior edge of the ulna in one of the specimens.”

To **PREVENT DECELERATION INJURY** on follow through you should pick a finish point that is right around / before hyperextension / lockout and always finish your shooting motion by that point.
It's important that shooters deliberately train to prevent shooting related injuries during deceleration.

Simple form training will help prevent elbow and wrist injuries. These kind of shooting injuries are 100% avoidable.
Resistance Training

*Improve Force Application and Energy Transfer*

Resistance training triggers changes in the body that allows us to handle greater force loads for energy transfer, as well as handle the same force loads for energy transfer safer.

“The benefits of resistance training in both competitive and recreational athletes have been well documented over the past 20 years. Improvements in muscle strength and power, increase in muscle size, and improvement in sports performance are common benefits resulting from resistance training programs. In addition, resistance training has also been suggested to reduce the risk for musculoskeletal injuries, or perhaps reduce the severity of such injury. Although studies reporting the direct effect of resistance training on injury rate reduction are limited, the physiological adaptations seen consequent to resistance training on bone, connective tissue and muscle does imply enhanced protection against injury for individuals who participate in such a training program. “

https://www.acsm.org/docs/current-comments/rtandip.pdf

In “Physics and Mechanics of Shooting” we studied the jump shot as a lowering of mass, force application into the ground, and energy transfer upwards via pull and push forces on the ball.

The specific resistance training / weight lifting sequence that mimics the physical jumpshot the closest is the olympic “clean and jerk”.

1. Jumpshot- Ground Push, to Pull, to Clean and Jerk
2. Clean and Jerk - Ground Push, to Pull, to Overhead Push
The clean and jerk involves greater force loads than in a jumpshot. Training to handle these greater force loads can help us apply more force in our shooting sequence and/or be more efficient in energy transfer upwards.

Thus this kind of resistance training can improve our arc, improve our range, and help prevent all kinds of jump shooting related injuries.

If you pick one exercise to improve force application, energy transfer, and deceleration, pick this one. If the movement is too complex to you, start by breaking it down into parts. ALWAYS err on “too little” weight than too much. The goal is to learn the form for efficient movement.

The main distinction between jump shot shooting form and olympic lifting form is jump shooting involves a horizontal release velocity, whereas the clean and jerk is purely overhead.

For this reason shooters may find benefit from horizontal pushing exercises - push up, bench press, and tricep extension.

If we consider shooting as a rotational movement, shooters may also find benefit from various rotational exercises. Clean and jerk is not a rotational exercise so it has limitations.

Shooters may also find benefit in learning various other complex force application/kinetic energy transfer movements - swinging, throwing, striking, and kicking. Learning a greater MOVEMENT VOCABULARY will improve our comprehension and understanding of force application and kinetic energy transfer in shooting.

When we consider the shooting motion as containing a sequence of force applications for energy transfer - ground reaction force, pull force, push force, and deceleration forces on follow through we see how resistance training can produce major benefit to a shooter - improved range and arc, as well as protection from shooting related injuries.

When using these resistance and athletic training exercises to improve our shooting and prevent injury we should take advantage of the scientific learning principles outlined in this book -

**Space out resistance training.** Less is more. Don’t train for many hours in one day.

**Record your sessions.** Review the footage and cut out the mistakes. Review the “makes” and rewatch them before sleep.

**Mentally rehearse your shooting** in replacement of workouts. Do this at down times, or do it before sleep for maximum benefit. Remember, our goal is to move more efficiently. Challenging the muscles with resistance helps, but just imagining it will improve our lifting and lowering form and abilities.
Experiment! Try out new workouts and reflect on how they relate to jump shooting. The more kinds of movement the greater our movement vocabulary, the better our understanding of efficient force application and energy transfer.

For each workout, practice on BOTH SIDES OF YOUR BODY for symmetrical body and improved understanding.

Use these scientific learning methods with resistance and athletic training to improve your force application and energy transfer as while as minimize injury related to shooting.