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## Quickstart Guide to Motor Learning for Golf

A practical look at  
how to practice more  
effectively and efficiently



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# Motor Learning = The process of improving motor skills through practice, with long-lasting changes in the capability for responding.



How to learn and practice golf efficiently and effectively is one of the places with the greatest potential gains for almost every golfer. It's a topic we don't talk about enough but can have a MASSIVE difference in the rate of improvement (or lack of) for most people.

Reality is most of us waste time practicing. And maybe deep down you know it, but simply don't know what to do. Your practice on the range isn't transferring to the course and the common "best practices" aren't based on research in learning and skill acquisition.

In this guide we're going to cover some of the primary topics around learning and practice to give you new frameworks and concepts on how you can improve your learning and practice.

Research tends to suggest that golf is a problem solving process. The problem is how to get the ball from point A to point B and the solution is the type of swing and shot that you implement. We need to understand that the reality is there are countless different ways to accomplish this.

The best way to practice is to create a new problem on each shot and find your best solution. Each shot should be a simulation of something you might encounter on the golf course in a performance environment.

When you're practicing each time you hit

another ball, create a new problem and decide how you're going to get that shot from point A to point B. Even if you're hitting the same club you can come up with a completely different way of hitting that shot and finding a solution. Think high vs low, fade vs draw, half shot vs full shot etc...

What most practice ignores is the main goal, retention and transfer. We really want to recall what we're learning and practicing on the golf course. At it's core golf is transfer activity because you never really have the same shot twice out in the golf course.

You have to be able to apply what you're learning and practicing under new situations, new conditions, and pressure.

We want to structure practice conditions to be most effective in order to play better on the golf course.

# Performance vs. Learning



Most people confuse their learning with immediate performance. The distinction between learning and performance is fundamental going back decades in research both with animals and humans.

Performance is what you can observe and measure during the time people are trying to learn or execute a skill they've been taught.

Learning will only become apparent at a later time when it matters. Can you transfer from what you've done in a practice environment to a performance environment, and can you apply this learning to any new situation?

This quote from the incredible paper "Learning Versus Performance" by Nicholas C. Soderstrom and Robert A. Bjork set the groundwork for what we're looking for in a learning environment.

"Conditions that induce the most errors during acquisition are often the very conditions that lead to the most learning!

Furthermore, that performance is often fleeting and, consequently, a highly imperfect index of learning does not appear to be appreciated by learners or instructors who frequently misinterpret short-term performance as a guide to long-term learning." (Soderstrom & Bjork, 2013)

It's very easy for people to think that their current performance during training is an accurate measure of how well they're learning.

*It's not only NOT accurate, it's very, very misleading.*

That's because conditions that can lead to rapid improvement in performance during learning do not support long-term retention of skills. In contrast, conditions that create challenges for the learners lead to better performance when it counts on the golf course in the future.

Most people think of practice as a way to measure where they're at today, how does it feel, where is the ball going, how well can you do. Most people fall into what is called block practice, hitting one ball, pulling another over hitting it and never really thinking about what they're doing or aiming at anything in particular.

*Very little learning happens with that kind of blocked mass practice.*

This kind of practice leads to better performance in the short term (while you're on the range) but does not indicate how well you can perform at a later time.

During a round of golf, you won't have the opportunity to repeat the same shot as you can in block practice. On the course you have to go to the next shot hitting a different club from a different lie to a different target.

Because of the emphasis on talent and innate abilities then we often view the difficulties surrounding practice in a negative light. We end up predicting our future learning based on the performance of today's practice.

Often if someone recently performed really well in a practice session, they predict that their performance on the course will match that of the range... In most cases that's not what happens. We often set expectations that are very high on the golf course and when you perform below those it can have a drastic impact on confidence and lead to doubt.

Author of the book "Real Golf" and golf coach, Joe Bosco has a unique way of helping players understand what their range game looks like on the golf course. He has his students play a personal best ball hitting 3 shots from the same point and taking the best shot.

What you realize is that you really do have the skills given the opportunity to practice a number of shots. But in competition or performance we only have one shot so we have to find ways to improve our practice and transfer our best game to the course.

What we're looking for are "desirable difficulties" during our practice and learning.

If you get someone practicing at the proper level of difficulty then their performance during practice will be a little lower than they might expect.

"...equip the learner with the type of knowledge or skills that are durable (i.e., capable of sustaining long periods of disuse) and flexible (i.e., capable of being applied in different contexts). That is, the goal of instruction is to facilitate learning, which must be inferred at some point after instruction." (Soderstrom & Bjork, 2013)

Although they feel a little deflated, when they go on to the golf course and start performing to the actual skill level, their mindset is a little different because they are performing better than their expectations which raises confidence. Alongside the improved confidence and self esteem that can be created through the use of better practice, what can be evident is greater emotional control.

If there is any sport that requires someone to be DURABLE and FLEXIBLE it's golf. We're talking about dealing with ever changing environments and problems under immense pressure.

So your practice and learning needs you to prepare you for those problems you'll face in a FUTURE performance. We're looking for those skills you've learned and practice to continue on with you into the future.

# CHALLENGE POINT

Desirable difficulties are “desirable” up until a certain point.

Too much or too little difficulty and then the learning is minimized. The goal is to be optimally challenged for success during the round, and not success during practice.

It's a mistake a lot of people make; they think that if they are doing well in practice what they are practicing will transfer to the golf course, when in reality short term gains do not have long term implications.

“The optimal challenge point for learning does not coincide with the optimal challenge schedule for immediate (practice) performance.”

(Guadagnoli & Lee 2004)

Challenge Point is the piece of the puzzle that brings all the aspects of random interleaved, variable, game like practice and personalizes it for each golfer (we'll talk about these further along in the guide).

There is no one-size-fits-all approach for practice and each individual needs to have their learning at a proper level of difficulty. Thus the term Challenge Point coined by Dr Tim Lee and Dr. Mark Guadagnoli in their paper - Challenge Point: A Framework for Conceptualizing the Effects of Various Practice Conditions in Motor Learning.

When talking with Dr. Mark Guadagnoli he shared an analogy which really brings this to light. Think about it like lifting weights; if you are lifting weights and it's easy, you are not improving. That makes sense from a physiological perspective, but we

don't relate it to a cognitive perspective often enough. If you do ten reps of a bench-press, it's really only the last three or four reps where you are struggling that bring about growth, and it's the exact same thing in any kind of learning. But if you're struggling on the very first rep, that's too much challenge. That's not a desirable difficulty, that's a beyond desirable difficulty. And so we have the sort of goldilocks complex where there is a sweet spot right in the middle; not too much not too little, and really part of the art of finding the optimal challenge point.

We have to look at a couple of different factors:

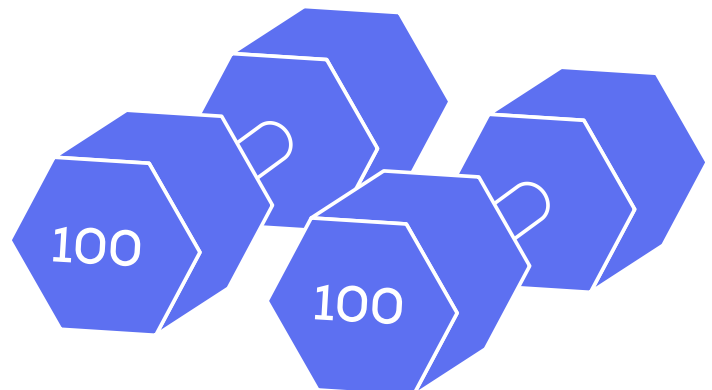
#1 - The difficulty of the task.

#2 - The performance of the learner during practice

#3 - Potential long-term learning benefit.

What most people don't fully understand about practice and learning is that making mistakes is okay. It's a part of the process that everyone needs to go through.

The myth is that making errors in practice is going to promote making more errors in performance, however an effective learning environment is going to challenge the learner and a byproduct of that is mistakes.



Author of the "Practice Manual" and golf coach Adam Young suggests this about setting appropriate difficulties:

"If someone is achieving a seven out of ten success rate in the task that I have set, I would consider it too easy and I would increase the difficulty incrementally by adding another constraint, or adding some level of difficulty.

And the reverse is true if someone is only getting three out of ten success rate in the task; I would lower the difficulty level so that it encourages confidence and a feeling that the player is learning."

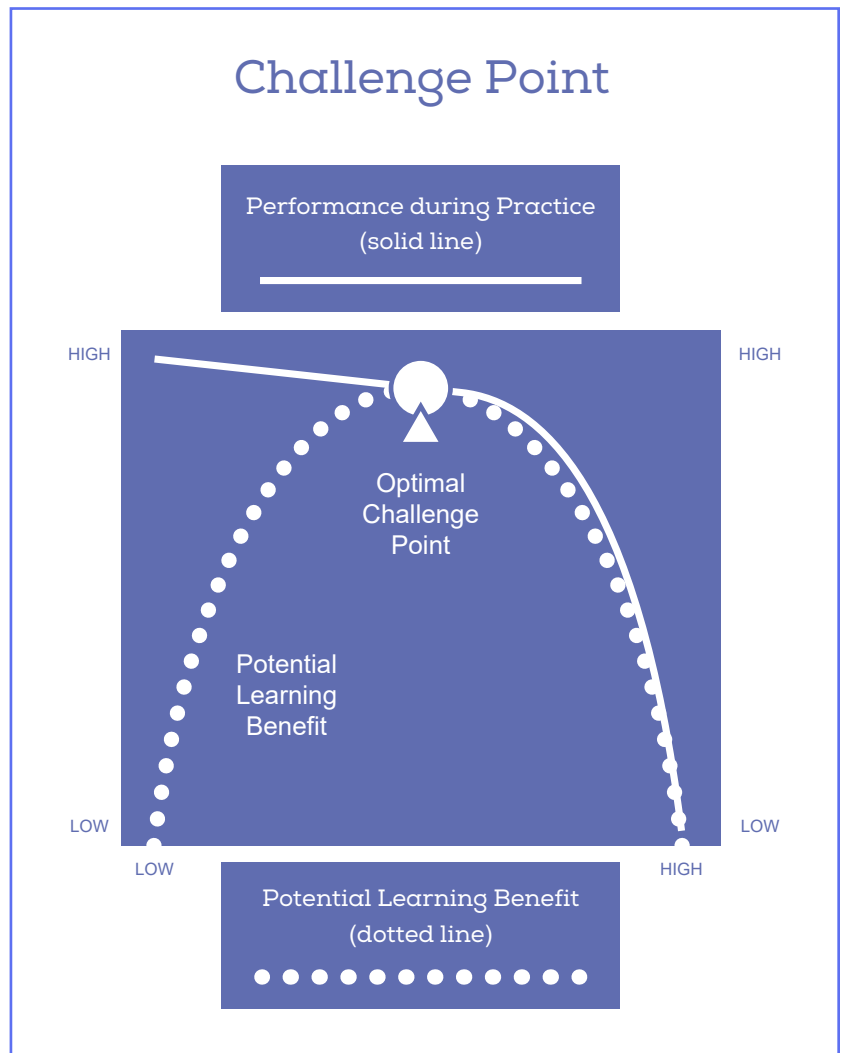
As you learn and grow - your level of desirable difficulties needs to change appropriately.

If that does NOT happen you'll see your learning and improvement beginning to flat line and become stagnant. If you ever get "comfortable" you know you're probably not setting up your optimal challenge point during practice.

The best practice for you today, may not be the best practice for you a week from now. However, a lot of people practice the same way over and over and over again, and what challenge point illustrates is that you reach a point of diminishing returns.

That's why a lot of people tend to get better and then level off because they haven't continued to challenge themselves during their practice and learning.

Some of this is simply because of routines and habits but can also be because of the fear of mistakes and potential embarrassment. When you reach a level of success many times people are too afraid to let go of their current performance, potentially making errors, to reach the next level.



You have to be willing to let go of the good today to find the improvement and greatness tomorrow.

# RANDOM AND BLOCK PRACTICE



Research on random and block practice started in 1979, by Shea and Morgan with a study comparing two groups.

Each group of individuals practiced three different variations of a motor skill. They had 18 practice trials of each task.

In block practice they would practice task A for 18 trials in a row, task B for 18 trials in a row and task C for 18 trials in a row. It was a very regimented type of practice with minimal amount of interference from task to task.

That was opposite for the second group which they called the random group. This group practiced no more than two trials of any one task in a row. For example the second group would practice: Task A - Task B - Task A - Task C - Task C - Task A and so on. Although both groups completed the same amount of trials one was completely random (also referred to as interleaved practice) with the notion that there is no minimal amount of repetition of the same task.

So what happened?

Block practice users had better performance during the initial trial.

If you can do something 18 times in a row you get better at that task quickly. If your goal is to make a quick adjustment for immediate performance then block practice will most likely have better results.

The larger concern for Shea and Morgan was retention. They asked people to come back for retention tests several days later to see how well they were able to perform the same tasks.

They found that although the block group did very well during the initial assessment, when they returned they did very poorly. In fact, they performed as if they had never practiced the task before.

On the other hand the random group did not perform well during the initial stage, but retained what they had learned.

They found that block practice is good if you



want to show temporary effects of improved performance but if you want long-term benefits and transferred ability you are better off with random practice.

“Random practice “works” because it encourages the learner to plan the movement in the interval just before the practice attempt; blocked practice eliminates this necessity, allowing the performer to reuse planning from the previous trial(s).” (Lee & Schmidt 2010)

## How does this transfer to learning and practicing golf?

The answer depends on a number of factors, about the individual, the skill level and goals.

For a beginner, you might want to introduce more block practice than you would with a highly skilled player. For a beginner they'll see success sooner encouraging them to continue learning.

A highly skilled player should use random practice throughout the entire session for better retention and long-term learning.

## VARIABLE AND INTERLEAVED

Two techniques in practice that are vital to understand in the context of random and block practice are variable and interleaved.

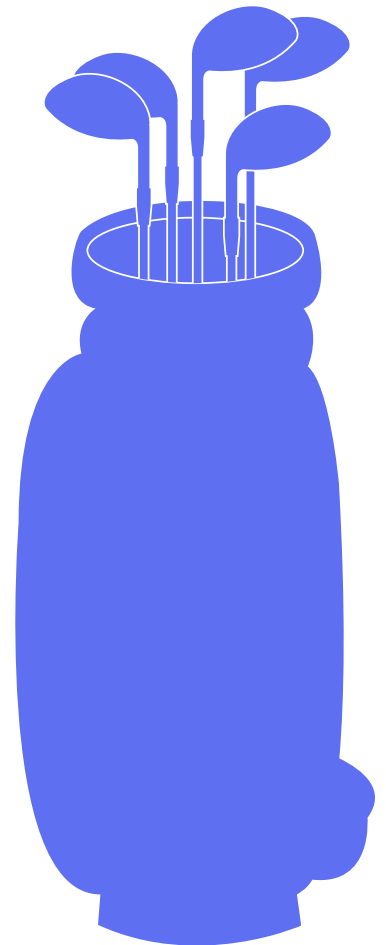
### Variable Practice:

Variable practice is finding different solutions to a problem. You have a goal to hit the green with your 7 iron but you're going to hit one right to left extremely high and then the next shot right to left that's very low.

You have the same lie, stance, club, and target but you're using a different “solution” to solve the problem.

### Interleaved Practice:

In the context of golf interleaved practice could simply look like switching between clubs for each shot, changing the target, or lie to give you a different problem to solve for each shot.



# HOW THE PRACTICE ENVIRONMENT SHOULD BE SET UP

The problem with most ranges (the average golfers practice and learning environment) is the difficulty level... It's simply not challenging golfers in the correct way.

When most people go to the range they spend a majority of the time on a flat piece of ground setting up perfect lies with their favorite club. It's the easiest thing to practice and has very little to no desirable difficulties involved.

The reality is people enjoy working on things that are easy and they're good at far more than challenging themselves appropriately.

To give yourself problems to find solutions to an ideal practice environment should have what you'd find on a golf course like sidehill lies, rough, bunkers, obstacles to hit around, and anything else you might encounter when on the course.

"In our view, an "optimal" driving range would have a number of deliberately nonflat lies, with varying turf, with targets on the range that mimic both greens and nongreen targets (for playing lay-up shots), with objects placed in front of the golfer to encourage shots to be played over, under, and around them, and so on. The idea is to make the driving range as similar to the actual play-on-course as possible." (Lee & Schmidt 2010)

Here's an example of the issues with a "perfect" practice environment from golf coach Peter Arnott:

Two years ago, I had a Nigerian client come across, he was studying to be a doctor at a nearby university. He had golf lessons on a driving range in Nigeria, and was still a complete beginner. He came to our indoor area and hit about 15 to 20 minutes worth of shots, never missing the ball once.

Then I wanted to put him into a realistic environment, so I took him out to the course and set him on the downhill line, what do you think happened?

He missed the ball seven times in a row. He had never been in an environment like that so he didn't know how to hit that shot.

If possible the best practice and learning environment is the course itself, practicing shots you might have to hit during a normal round.

# EXTERNAL FOCUS

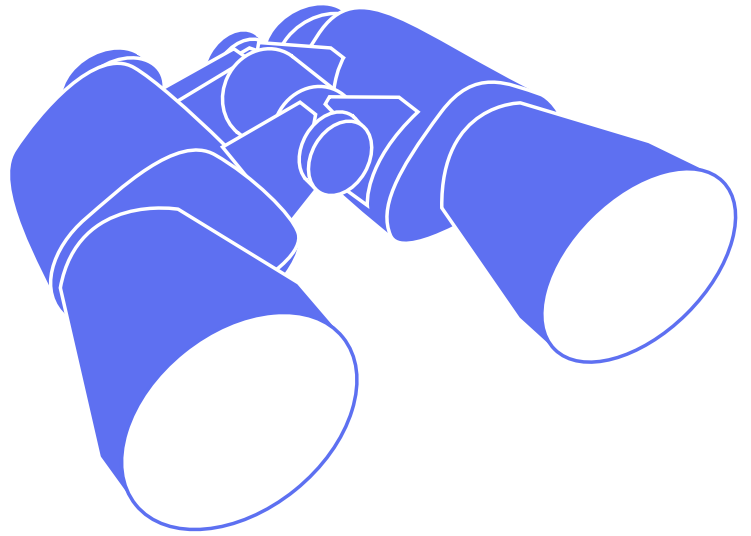
Most people naturally use internal focus and teachers typically start by giving instructions that refer to body movements. For example “Change the way your wrist moves,” or “Your hips should be shifting like this.”

An external focus, on the other hand, is on the intended move and effect. It can be everything from, “push against the ground with your left foot” to “feel the shaft of the club point at the target” and even “focus on the flag”.

Dr. Gabriele Wulf has put together some incredible research on this topic which is worth reviewing in her paper “Attentional focus and motor learning: a review of 15 years”.

“... a person’s attentional focus often has a similar influence on both immediate performance (i.e., during the practice phase when focus instructions are given) and learning, which reflects a more permanent change in the capability to perform a skill, and is measured by retention or transfer tests (i.e., after a certain interval and without instructions or reminders).” (Wulf, 2012)

So why does an external focus work better? When you focus on body movements, you consciously try to control movements and in turn lose the fluidity and cause tension in movement. There was an interesting study done with dart players that illustrates this concept. The players who were asked to focus on an external result performed better than those given an internal cue of their body. Although the results were better



“...analyses of movement kinematics and kinetics used in some recent studies have shown that whole-body coordination patterns seem to be optimized with external focus as well” (Wulf, 2012)

for the players given an external cue the variability between throws was greater (the way they threw the dart).

What this means is precise repetition of a movement isn’t the goal for better results!

Internal focus disrupts the fluidity of the movement, uses more energy than necessary, and the accuracy of movements are degraded. However, when you use external focus, you use more automatic control processes which are unconscious, much faster, and as a result, movements are more efficient, more fluid, and more accurate.

Immediate performance and long-term learning are sped up using an external focus.

In golf you have to adapt to ever changing environments and conditions. There is going to be VARIABILITY and to adapt your body needs to be as fluid as possible. Thus an external focus improves performance.

## Proximal vs Distal Focus:

When looking at external focus there's a big difference between pushing on the ground with your foot to focusing on the target.

A focus close to you is considered proximal and farther away is distal. For example a proximal

"Bell and Hardy's study demonstrated greater accuracy in hitting golf balls when the focus was on the ball trajectory and landing point (distal) compared to the club (proximal)." (Wulf, 2012)

focus would be the club face and a more distal focus would be the flight of the ball. What is usually found is that performance is further enhanced by a more distal or distant focus.

However, the optimal distance of the focus seems to depend on the skill level. For a highly skilled golfer, a more distal focus like the target or trajectory of the ball is likely more optimal. But for a novice golfer a focus on the club or club face is going to be more effective as they still have to learn the skills of how to hit the shot in comparison to an expert.

External focus really has two advantages:

#1 - Keeps the focus on the target and on the intended movement goal.

#2 - It directs attention away from the self, specifically the body.

There are likely thousands of training aids and feedback devices on the golf market. Most of them have some amazing success stories about how this certain tool stopped the user's slice instantly or how they started making 99% of their 5 foot putts.

But reality is we know most people don't use guidance and feedback devices (training aids) properly.

We have to start with the premise of what's required on the golf course and base that environment as the starting point for setting up effective practice.

When you're in a performance environment on the golf course, you don't have a guidance device with you, you don't have an instructor with you, you don't have anything except your own awareness and feedback sources available to you - seeing, feeling and hearing.

Here's an example from Dr. Tim Lee that illustrates this premise really well:

"Let's take a putting device that keeps your putting swing in a straight line as you take a stroke.

Rather than focusing on trying to learn how to use the guidance device, think about how the guidance device can help you learn how to interpret your own source of feedback.

What does the guidance device tell you or help you learn about your own feedback

you receive as you're swinging that club?

Not only that, but how can you best learn from that guidance device and how can you set up practice in order to best learn from it? One of the things that we've learned through research is that, probably the worst way of doing it is to use it multiple times in a row."

Our goal is to optimize our ability to use those sources of feedback and set up conditions of practice so that we can optimize learning.

When using a guidance device try to use it once and then take the guidance device away and see if you can simulate the same feelings and movements. Try hitting one ball with the guidance and then ten balls without trying to find your own sources of feedback that are beyond the training aid.

Instead of learning how to use the guidance device, use the guidance device as a way to learn your own sources of feedback.

Guidance devices help early on but lose their effectiveness over a period of time. The goal is to become less and less dependent on the guidance device and find your own sources of feedback to look to.

Dr. Tim Lee shares another great illustration of this concept:

"I like to think of guidance device as a form of a dictionary. You only go to a dictionary if you are uncertain about what the spelling is, but you don't look up every word in the dictionary if you're confident of how to spell it.

You only use the dictionary as a gold standard for when you're uncertain about your own spelling and when you think about coaches and guidance devices you really only need to use them when you don't know how to interpret your own source of feedback.

You don't go to the dictionary when you know how to spell the word, you shouldn't have to go to the coach or guidance device unless you're uncertain about what it is you're trying to learn."

The coach or teacher like a guidance device is there to help you to understand the feedback you're not able to interpret by yourself.

Your coach can help you feel a new feeling and make a change, but ultimately you have to learn to make the adjustment yourself. It has to transfer to the golf course or even practice when your teacher or coach is no longer there giving feedback.

## Key Concepts on Guidance and Feedback:

Don't hit ball after ball with a guidance or feedback device.

Reflect on the feelings and sensation with and without the feedback or guidance device.

Try to interpret what's wrong before asking for feedback or going back to a guidance device.

Don't mindlessly train with a guidance device or receive feedback after every shot you hit with a coach. The goal is to NOT become reliant on feedback you can't receive during performance on the golf course.

Although a guidance device can get you to "perfect performance" the retention of that performance is short lived and is certainly not durable or flexible enough to hold up under the changing conditions and pressure of performance.

## Better Expectations and Positive Motivations

There was an excellent study done recently (Palmer, Chiviawosky, & Gabriele Wulf, 2015) which looked at the differences in learning and performance when players viewed their results as either “good” or “bad”.

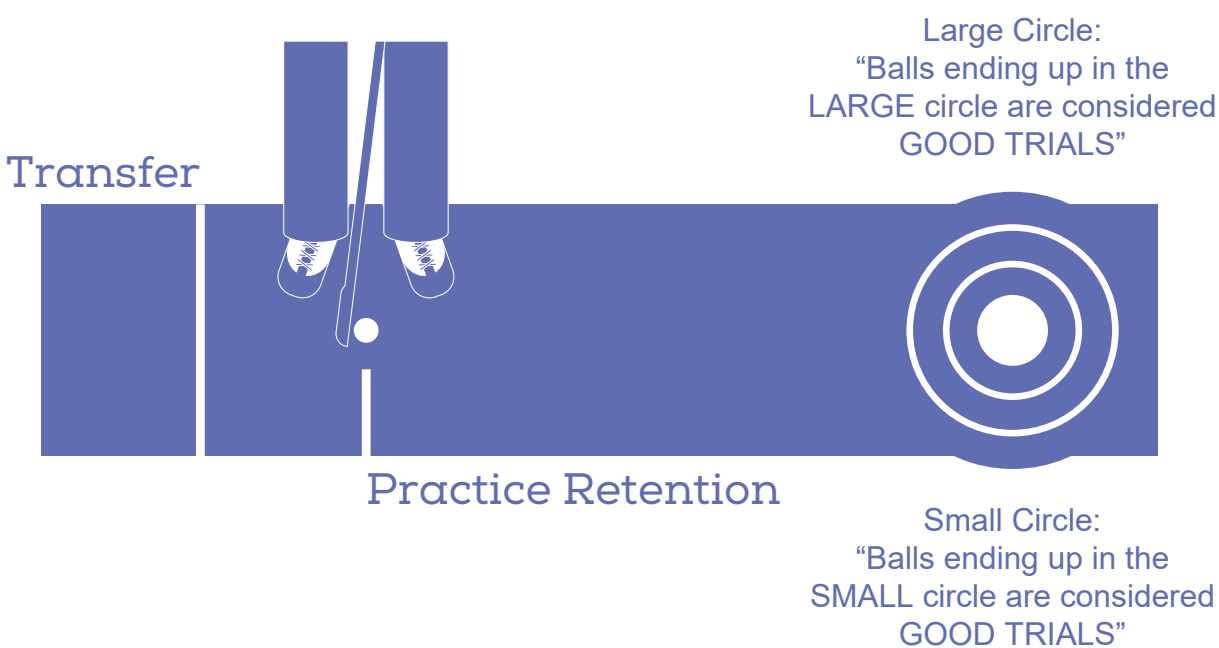
The theory was to see if by providing a false sense of good performance they could enhance learning. You can see in the illustration an idea of what the test looked like to give different individuals an idea of how they were doing in the task.

What they found is that the individuals who putted with the larger circle as being good had more success during the practice and performance phase as those putting to the small circle. This trend continued with the retention and transfer tests later on.

How we view our shots (good or bad) has a direct influence on the learning we take away from that practice.

The takeaway? Set realistic expectations. If you’re a 20 handicapper don’t be comparing your drives to that of a scratch golfer. If you’re a 10 handicapper you’re not going to hit the green 70% of the time so don’t get so bent out of shape when you do miss one..

“By creating conditions that increase the learner’s feelings of competence... instructors or coaches can enhance performance and speed the learning process.” (Palmer, Chiviawosky, & Gabriele Wulf, 2015)



In a recent interview, Dr. Rebecca Lewthwaite shared her suggestions on how to best go about this.

“There are really several ways you can go about creating this positive motivational opportunity.

One is to enhance the sense that one has been successful as you go forward, and the other is to provide people with opportunities to choose or to have autonomy in their actions.

So, one way you could pair these things is tell people early on, it’s quite good if you can hit this target or be close to it in this way, provide them with positive feedback, you know, “For that early trial, it was excellent.”

And then the next thing you could say is, “Let me know when you would like to get some more specific feedback.” So it’s an invitation to have to take a little charge of when you get further detail or when you dive into it more deeply.”

## Autonomy:

Another factor to enhance learning is autonomy or choice in the learning environment.

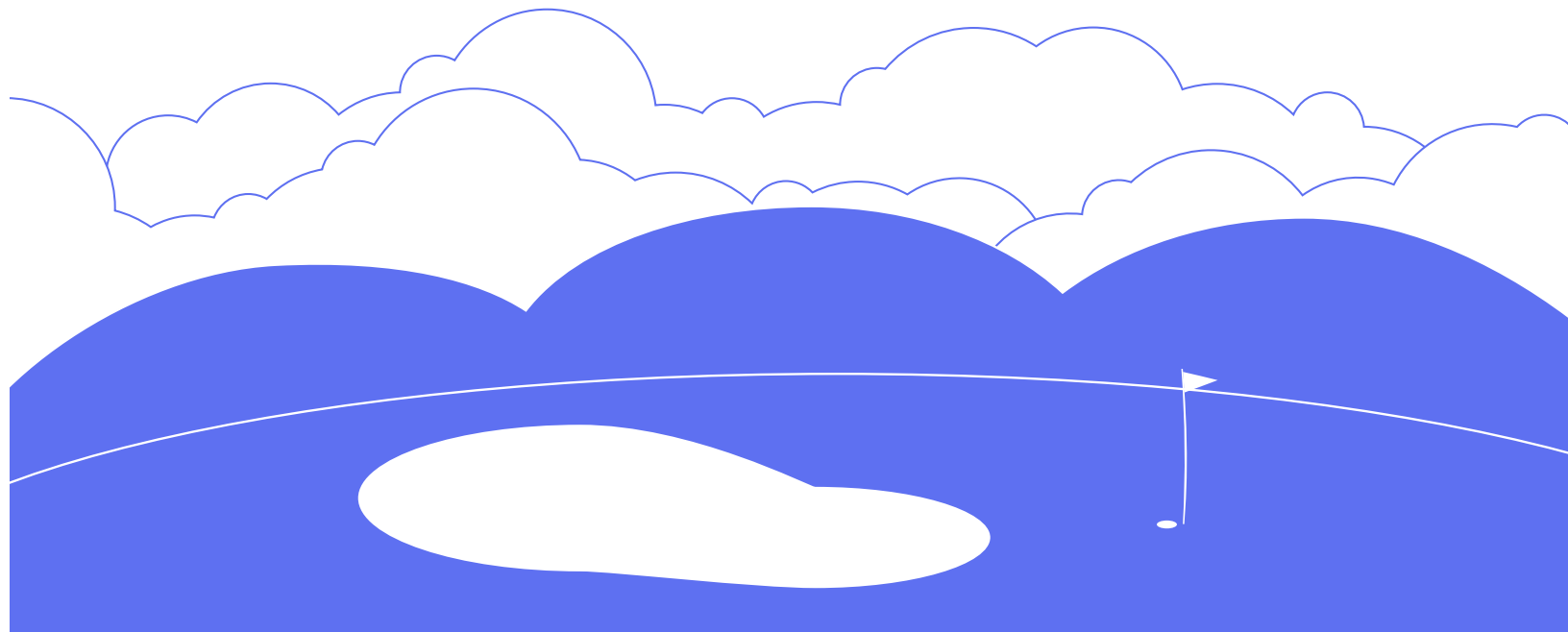
What has been found is that a choice REGARDLESS of whether it is related to what is being learned or not had a positive impact on learning.

For example a recent study was done in which they asked participants to complete a putting task. They divided up two groups of golfers and gave one group the choice of what color golf ball they would practice with and the other was given no choice.

The result for the group with the choice was better retained learning.

Obviously the color of each golf ball has no impact on how someone performs and learns. This unassociated choice helped individuals to perform better.





Ecological psychology is the study of how organisms act in their environment, how they adapt, and how they ultimately become functional in those environments.

One of the key concepts is that we are able to adapt to the environment and find our own solutions to the problems presented.

The goal with the ecological dynamics approach is that you don't give the organism any solutions just appropriate problems and then let the organism come up with a solution.

This reverses the paradigm of "programming" the organism with a solution (which we most often try to do in golf). Technically creating good "looking" swings and attempting to model others doesn't help each individual find their own functional swing and solution.

We all act with creativity and have a different solution.

If you look at the PGA Tour you'll find completely different movement patterns (swings) but they are all functional in their environment (shooting low scores and winning tournaments). They're behaving functionally in the environment and coming up with unique solutions.

## Dynamical systems theory is the study of how and why systems change over time.

By providing people with an appropriate environment and an appropriate level of difficulty you'll see a high level of self-organization. If we don't self-organize to the demands of the environment then we won't inhabit that environment for very long because we are not able to behave functionally.

Coaches need to make sure that with an ecological dynamics framework, you are providing the right environment for students.

Here's an example from Golf and Sports Coaching lecturer at the SRUC in Scotland, Graeme McDowall

One of my favorite examples is from PGA tour players when you ask them how they got good at the game and they always start off by saying "I was lucky".

I was lucky because I lived very close to a golf course and I was able to play golf every day. I was lucky because my granddad played golf, he was an example and he gave me some clubs that we cut down and I played golf every day and as I got better, I was able to play with better players.

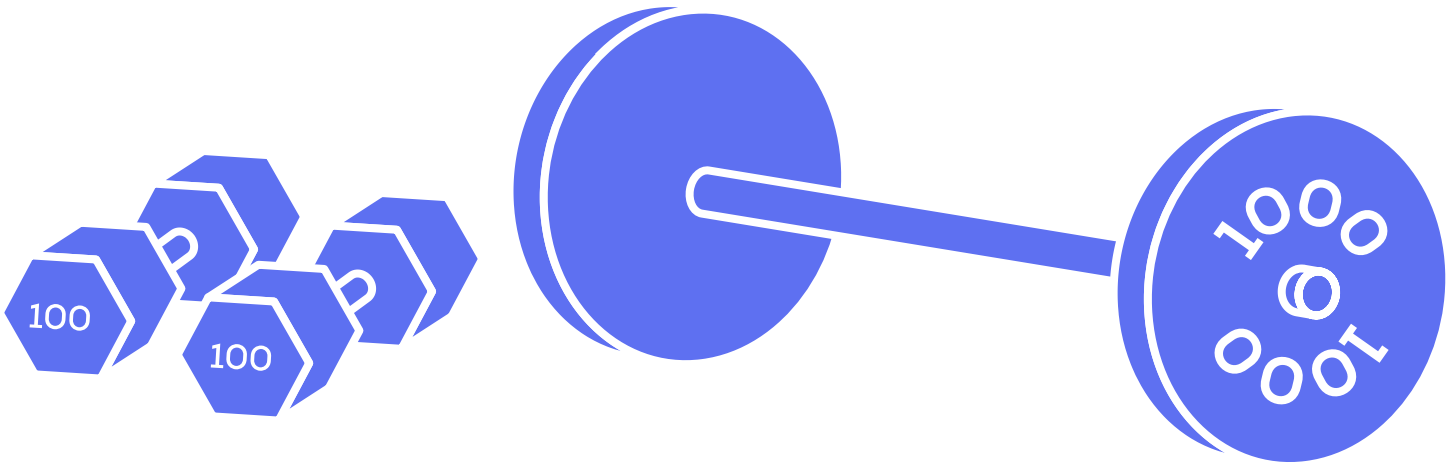
Then I progressively got better and better and I was able to play at a better golf course in

the area that was a championship course and there were better players to compete against there.

So we have these emerging examples of people growing the skill level relative to their environments.

So what's in the environment there that I just described? Well there is access to good players and progressively better players, so they got better, the level of competition got better and the difficulty of the golf course got harder. So they grew their skill into environments and stimulating that growth was harder competition and harder golf course, but luck and also opportunity to do that.

# CONSTRAINT BASED COACHING



Based on the ecological dynamics model a constraint led approach to coaching is to create problems and then challenge the learner to come up with solutions to those problems. The solutions could then help to change a motor pattern or another aspect that was holding the learner back from a solution.

From a scientific standpoint an organism is being moved away from its equilibrium to what we call a bifurcation point where you force the system to branch out and try something new to bring order back to the situation. That means learning new motor patterns, new strategies, new thought patterns.

The goal with constraint based coaching is to train players beyond the needs of performance. If you're training level is high, or above the needs of performance, when you actually need to perform in competition it becomes easier.

The problem is most golfers train below the needs of performance and when they actually try and perform on the golf course it's exponentially harder than the range.

Golf Coach Peter Arnott shares a great example:

Basically I call this constraint based game "How low can you go".

It's six hours on the golf course or until the task is completed. I had a player that was really technically focused and had forgotten how to score, young pro who played competitively. I simply wanted him to figure out how to score again. His goal was to get to 10 under par playing junior or ladies tees and he was out there for six hours until he accomplished that task.

It's setting up problems for the golfer to solve so the learners can take more responsibility for their learning.

Each individual's solution to a problem is different. Constraint based coaching is all about letting the individual find a way that is fit for them to solve the problem instead of giving them the answers.

# Repetition Without Repetition

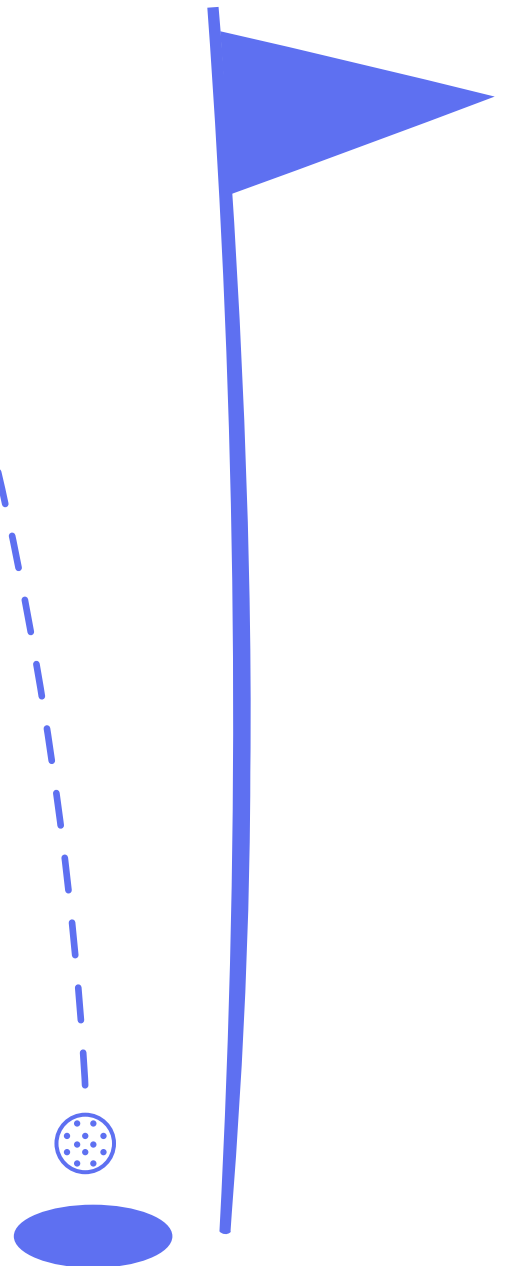
A wise quote was once published -  
"Repetition is the mother of skill" by  
Tony Robbins, which many attach to the  
"We are what we repeatedly do" from  
Aristotle.

These are incredible quotes, and are 100% true, correct and magnificent. However, the golfing population and many instructors out there have been misled or have misinterpreted them too many times.

There is a distinction between what exactly is to be repeated. Mere repetition of a movement does not ultimately mean with 10 thousand more repetitions I will be good at this move. It doesn't mean that the move will become imprinted in one's mind and forever in their ability to execute upon desire.

Skill, by definition, is the ability to do something well. So planning a movement, executing the movement and reflecting on the outcome of the movement is the whole skill broken down. Here is where the repetition part comes into play.

By repeating this whole process we learn and our skills improve, so repetition is the mother of skill. But repetition of the whole skill is the only repetition that will help golfers.



# CONCLUSION

Hopefully, by now you have some ideas about how you can improve your learning and practice environments for better long term learning and improvement.

One part of the problem is the knowledge. Which hopefully you have a foundational understanding of now.

The second part is action. Commit yourself to making a change to start learning and practicing

more efficiently. If you do that you'll see improved growth and your skills improve as you begin to effectively practice and learn.

If it's not challenging and doesn't stretch you out of your comfort zone keep pushing the limits and working for long-term learning.

# ABOUT

I hope you enjoyed this look at what it takes to create a better learning and practice environment and start to implement this information.

At the Golf Science Lab we're focused on getting you research based information and concepts so you can actually improve and get better results on the golf course.

And don't forget to write me an email and let me know the impacts of better practice and learning habits have had on your game (I read every email).

Thanks for reading,

-Cordie

# REFERENCES

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