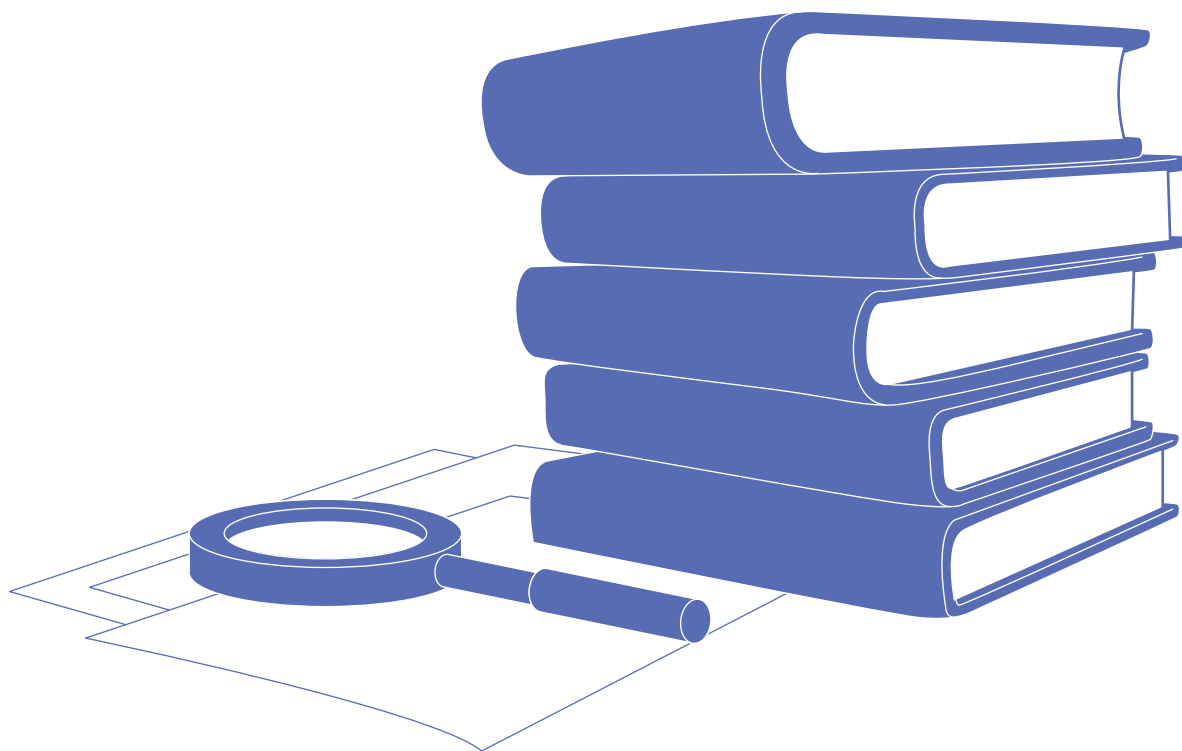
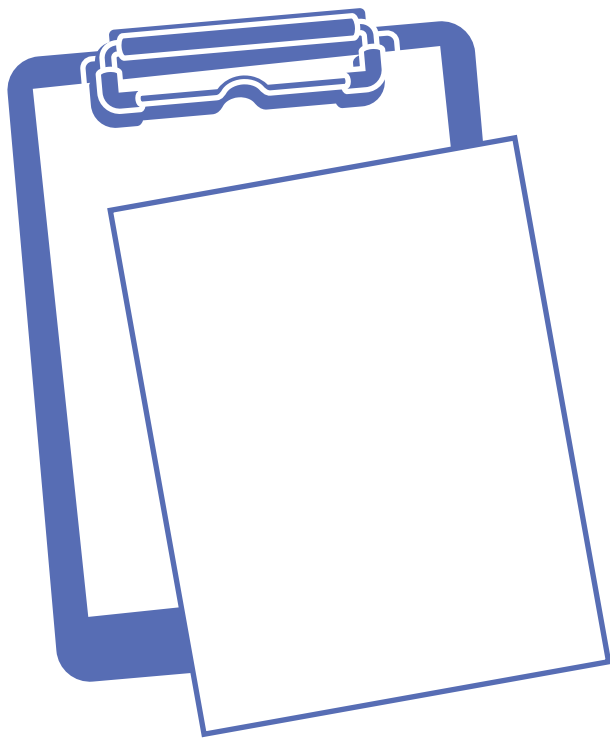


5 Critical Pieces of Research

All Golf Coaches
Need To Know About



There is a lot of incredibly valuable research going on in the fields of player development and learning that coaches need to be familiar with.



The golf-coaching world is changing, and it's for the better.

Coaches around the globe are paying more attention to developing great athletes and players.

These 5 pieces of research are a foundation for golf coaches, and an introduction toward changing the way golf is taught.

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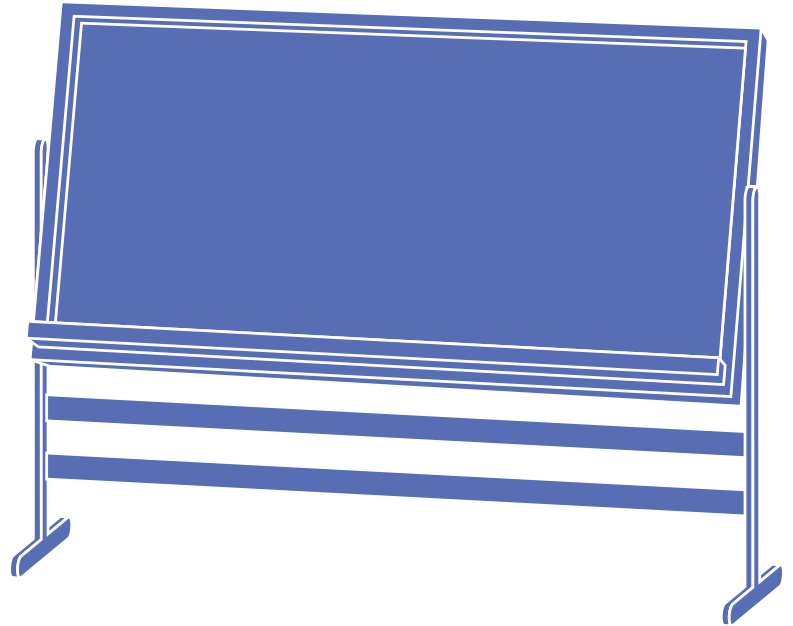
#1

Varying the Conditions of Learning

Conditions for learning have been misunderstood for some time.

We as golf coaches have been under the illusion that providing tasks in a fixed manner, also referred to as blocked/massed practice tasks, and conducting these practice tasks in one location helps in the development and acquisition of golf skills.

For decades we have instructed our students both young and old to complete a set number of learning trials of a particular drill. What was once believed (lots of repetitions doing this drill, in this place, will create muscle memory) has now been disproven, and suggestions toward a more effective way have been presented.



Don't believe that a task like this can't be correlated to golf? No doubt the tasks are different, however movement is not. Movement is the same process psychologically whether it is throwing a beanbag, or hitting a golf ball. Both have goals, and both require the body's movement to achieve the goals.

Dr. Robert Bjork from UCLA spoke at the 2016 PGA Teaching and Coaching Summit and shared some of his findings from Bjork's Learning and Forgetting Lab.

This is amongst an almost exhaustive list of studies providing the same conclusion.

A task was given to two different age groups, 8 year olds and 12 year olds. And the task was to toss beanbags to a target on the floor. One group was placed in the fixed group meaning they tossed the bags from a fixed distance,

which was the criterion distance.

The other group was placed in a varied group meaning they tossed the beanbags from a distance that was +/- one foot, which was never the criterion distance.

After the practice trials were conducted the two groups completed a test from the original criterion distance. What was found is the absolute error in inches was less, from both age groups, in the varied group than the fixed group.

What about if you were to change the location (varying the environmental conditions i.e. environmental context)?

Would that help, or harm the acquisition of skills?

Again Dr Bjork researched the concept and concluded that students who studied in multiple locations (different environments) tested better than those who studied in only one location. Changing the location, and altering the task is a strategic way of implementing what Dr. Bjork calls "Desirable Difficulties."

Come to think of it, when we perform on the golf course the environment on each shot is slightly different. And so practicing by varying the environmental conditions will help, not harm later performance.

References:

- Smith, S.M., Glenberg, A. & Bjork, R.A. Environmental context and human memory. *Memory & Cognition* (1978) 6: 342.
- Kerr, Robert, and Bernard Booth. 1978. Specific and varied practice of motor skill. *Perceptual and Motor Skills* 46: 395-401.
- Bjork, E. L., & Bjork, R. A. (2011). Making things hard on yourself, but in a good way: Creating desirable difficulties to enhance learning. In M. A. Gernsbacher, R. W. Pew, L. M. Hough, & J. R. Pomerantz (Eds.), *Psychology and the real world: Essays illustrating fundamental contributions to society* (pp. 56-64). New York: Worth Publishers

[Desirable Difficulties Video w/ Dr Fran Pirozzolo](#)

The Conclusion:

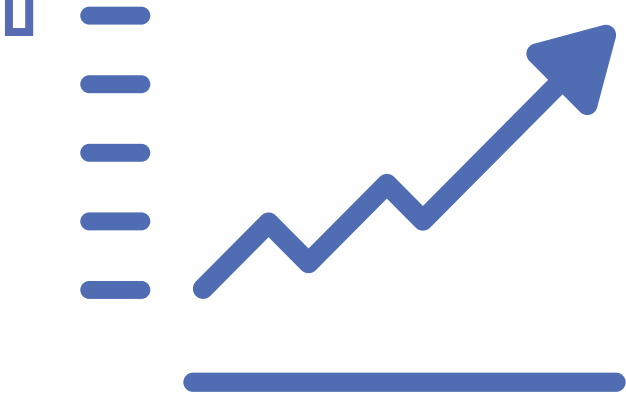
Practice needs to include variability within conditions that represent what a player would face on the golf course, which is never the same distance, or lie.

Practical Advice:

Don't have students hitting to the same distance with the same iron off a flat lie on the driving range. Add a little variation with key aspects like distance, and location. Do this by creating a learning environment (games / drills) that force students to change club selection, or club speeds, on different lies. This creates appropriate difficulty so golfers build skills that hold up on the golf course under pressure.

#2

Learning vs. Performance



An often-misunderstood concept is learning's relationship to performance, which is very different to what most coaches naturally think. This particular section dates back to the 1940's, and 50's, and is about the only thing that learning theorists agreed on.

Performance is something that is measurable, its viewable, right there and then. We can see how often they execute skills, and how well they execute them. Learning isn't like performance, and is actually inferred, meaning performance is not a very accurate predictor of the amount a golfer learns. In fact it is one of the worst predictors of learning. A golfer can achieve a lot of success in the moment, and execute some incredible shots at one time, yet learn almost nothing. Conversely golfers can execute very poor shots, and experience zero success, yet learn tremendous amounts.

This means that testing for learning needs to be done at a later date, where rounds of golf, or shot patterns start to emerge. It is very easy to jump to

conclusions about golfers knowledge, and skill sets before compiling an adequate amount of data, based off of very few performances or even one performance. Depending on the location, and the external, uncontrollable environmental factors, the score/performance of a golfer may change. Don't fall into the trap of believing the differences in performance correlate to the amount of learning. It happens all the time and is a huge mistake.

The Conclusion:

Sit tight, and hold your breath until patterns emerge. Don't determine the amount a golfer knows, or is capable of before you have seen them play a lot of golf. It is a general rule in the learning science domain to disassociate learning from performance.

Practical Advice:

Provide the resources for golfers to measure statistics, thoughts, and feelings so over time you can review and compare against aspects that need to be refreshed. Remember that the score is not a level of the amount a golfer has learned.

References:

Soderstrom, N. C., & Bjork, R. A. (2015). Learning versus performance: An integrative review. *Perspectives on Psychological Science*, 10, 176-199.

[Disassociating Learning and performance video](#)

[Distinction between learning and performance video](#)

#3

Contextual Interference

Context is everything, it is all around us at all the times, it is the environment we are in at any given moment, and it can shape how we learn, practice and perform. Understanding this can help in the design of new training environments.

Interference on the other hand is what often causes golfers to perform at a lower level of performance, whether it is external pressures or task difficulty, more often than not it blocks players potential. It is at no surprise that this happens when we observe how golf is usually taught, and practiced. Golfers very rarely practice in environments that provide an optimum level of interference for their current skill level.

Traditionally motor skills tasks have been taught and practiced in what is called a 'blocked' style, which is: Hit 25 10-foot putts in succession, then hit 25 40-foot pitch shots in succession. Here there are 25 learning trials in a row before moving on to another task, and 25 more learning trials after.

A technique called 'Interleaving' has become more popular over the past few years although not completely accepted, and this type of practice differs from blocked quite significantly.

Interleaving practice is for example: A golfer completing a total of 25 learning trials for both a putting task, and a pitching task, however not in succession but by conducting 1 putt, then 1 pitch 25 times. The same number of learning trials was

A study called 'Challenge Point: A Framework for Conceptualizing the Effects of Various Practice Conditions in Motor Learning' published by Mark A. Guadagnoli, and Timothy D. Lee claimed that depending on a golfer's skill level, their type of contextual interference (challenge point) would differ allowing for appropriate information processing. A golfer relatively new to the game of golf may benefit from a more blocked type of practice with relatively low levels of contextual interference, and golfers with more experience, and higher

skill level would benefit from a more interleaved type of practice with high levels of contextual interference. More research needs to be done in regards to an optimum challenge (contextual interference) point, however this makes sense and can help a golfer gradually improve their skills.

More research has been done by Dr. Robert Bjork, and colleagues suggesting that interleaving practice provides enough contextual interference to improve motor skills, procedural, perceptual, and conceptual skills.

completed by blocked practice, and interleaving practice, however interleaving changes the task constantly creating that contextual interference.

The Conclusion:

Golfers increase their abilities when they are provided contextual interference at the appropriate level. Contextual interference is created when golfers complete a set of tasks in a particular way i.e. blocked, which is a low level of interference, and interleaved, which is a higher amount of interference.

Practical Advice:

When providing exercises, and or practice drills make sure the order in which they are completed by the golfer is providing an appropriate amount of interference.

References:

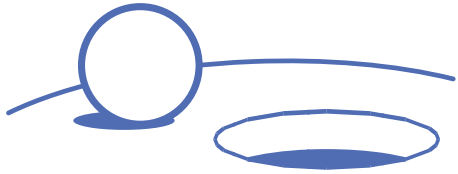
Mark Guadagnoli & Timothy Lee (2004): Challenge Point: A Framework for Conceptualizing the Effects of Various Practice Conditions in Motor Learning, Journal of Motor Behavior, 2004, Vol. 36, No. 2, 212-224

[Dr. Robert Bjork talking on interleaving practice](#)

[Dr. Doug Rohrer talking more on interleaving practice](#)

#4

Feedback



For years we have believed that feedback that is as frequent as possible, as immediate as possible, and as informational as possible, is beneficial for motor skill learning.

It only seems logical to think so too. If one wants to get better at something it would seem reasonable, and optimal to get feedback in a way described like the above.

It turns out that this is NOT helpful towards improving motor skills.

When looking deeper into feedback we come across two different types, 'Intrinsic, and Extrinsic (also referred to as augmented)'. Intrinsic is information received through ones senses such as seeing it, hearing it, and proprioceptive (feeling it) and Extrinsic feedback is information about performance that is by means of an external source like a coaches comments and suggestions, videos or pictures, auditory information recorded and played back, or physically restrictive guidance tools. 'Intrinsic' is inevitable, and 'Extrinsic' is manageable. Here's how to do it:

A study was conducted back in 1970 with Armstrong where participants learned to make a 3-sec spatial-temporal arm movement.

The study provided suggestions as to how we can improve feedback to enhance performance. Since that study there has been an abundant amount of examples published suggesting some very important ways for us to get better at playing golf, rather than getting better at practicing it.

One is that instant corrective augmented feedback can support performance while its present but does not aid in long-term learning, and later performance.

Conversely by reducing the amount of corrective feedback, or by providing feedback when performance is outside a certain bandwidth, then we begin to enhance learning.

Also by providing a way to individualize the amount of feedback to suit the needs of each learner, and involve the brain of the learner in the interpretation of feedback then learning is further promoted.

As well as 'Intrinsic' and 'Extrinsic' feedback, we can further categorize 'positive', and 'negative' as types of feedback due to the notable differences that occur in current, and later performance. It is evident that feedback is very important in the learning process, and so we should always seek to get better at providing it. A series of studies highlighted the importance of 'positive' feedback, which is feedback after a student's good trials. In the same studies feedback was also given after blocks of trials, NOT after each individual trial. It was concluded that in a study conducted by Gabriela Wulf, and Rebecca Lewthwaite called 'Optimizing Performance through Intrinsic Motivation and Attention for Learning: The Optimal Theory of Motor learning' feedback emphasizing successful performance, while ignoring less successful attempts, benefited learning.

What can be derived from all the research out in the world today is - a higher percentage of 'positive' 'extrinsic', and delayed feedback will result in greater learning, and higher levels of performance.

Dr. Fran Pirrozolo articulates extremely well in an article written for lasting learning - check it out here:

<http://www.lastinglearning.com/2016/04/18/mind-games-does-practice-make-perfect-it-depends-on-how-you-do-it/>

To download the research paper click this link:

<http://link.springer.com/article/10.3758/s13423-015-0999-9>

The Conclusion:

Providing the most appropriate feedback, which differs depending on the level of the golfer, one can facilitate and increase the speed in which skills are acquired.

Practical Advice:

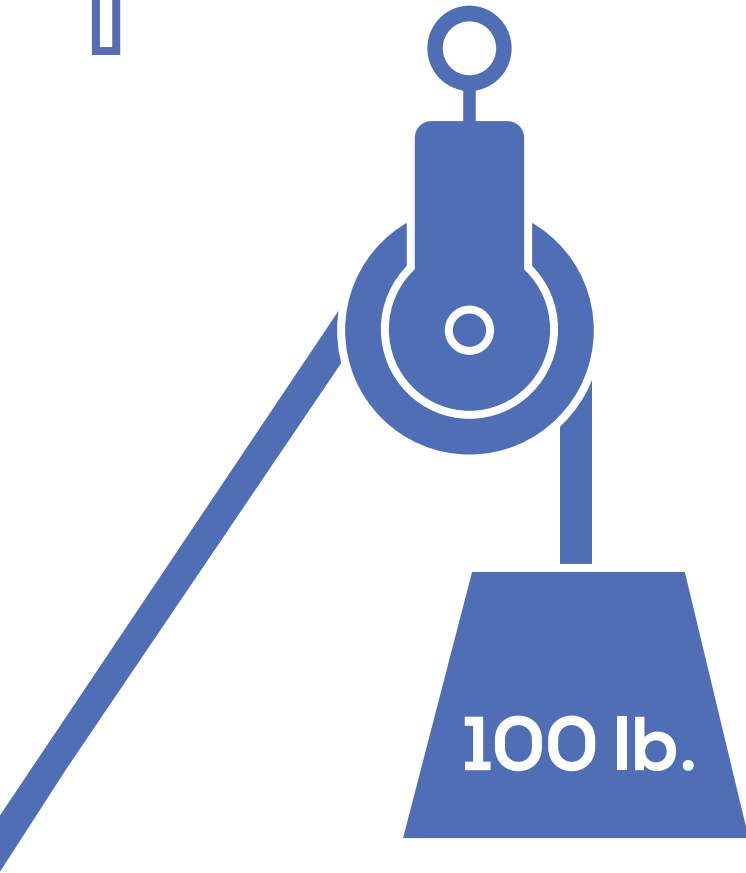
When working with golfers who are new to the game, or have a low level of skill it is appropriate to provide feedback more often i.e. after each golf shot. When working with golfers who have a high level of skill it is appropriate to delay the amount of feedback i.e. after a set of trials etc.

References:

- Schmidt, Richard A.; Young, Douglas E.; Swinnen, Stephan; Shapiro, Diane C. (1989) Summary Knowledge of Results for Skill Acquisition: Support for the Guidance Hypothesis Journal of Experimental Psychology. Learning, Memory & Cognition; Mar1989, Vol. 15 Issue 2, p352
- Smith PJI, Taylor SJ, Withers K. Applying bandwidth feedback scheduling to a golf shot. Res Q Exerc Sport. 1997 Sep; 68(3): 215-21.
- Wulf, G., & Lewthwaite, R. (2016). Optimizing Performance through Intrinsic Motivation and Attention for Learning: The OPTIMAL theory of motor learning. Psychonomic Bulletin & Review, doi: 10.3758/s13423-015-0999-9

#5

Self-Organization, Constraints, and Dynamical Systems



A paper titled 'Ecological dynamics and motor learning design in sports' written by Keith Davids, Duarte Araujo, Robert Hristovski, Pedro Passo and Jia Yi Chow provided some very constructive insights as to what the 'ecological dynamics' approach is, and its relationship between the learner, and the environment.

Here is an extract from the original paper:

Successful performance in sport is characterized by reproducing low-dimensional patterns of behavior, which are functional, consistent with respect to performance outcomes and resistant to perturbation (Warren, 2006). Low-dimensional patterns of behavior are relatively stable and coordinated movements that have been well practiced. They are less complex to perform since motor system degrees of freedom have been integrated into a functionally coherent and organized action, characteristic of a skilled athlete. Skilled performers are not locked into rigidly stable solutions (e.g. technical, tactical), but can modulate their behaviors to achieve consistent performance outcome goals, a capacity termed 'dexterity' (Bernstein, 1967, 1996; see also Davids et al., 2008). Successful performers are able to adapt their actions to dynamically shifting environments that characterize competitive sport.

The human body is a remarkable organism, and is more capable of performing functions than anyone might potentially think.

The fact that the human body can perform some of the tasks that it does in certain working environments such as military and piloting just shows how impressive the level of motor ability we as humans can potentially possess.

We are living organisms, and we are interacting with the world around us in many different ways. We perform different actions depending on the different types of stimulus we identify. For some time people argued it was genes verses environment, and environment verses genes, when really the 'verses' should be changed to 'multiply'. Genes multiplied by the environment can potentially produce incredible motor skill performance.

Studies were conducted in different sporting domains to further look into this phenominan (Basketball, boxing) and it was found that performers decisions emerged based on their perceptual attunement to key information sources. This conclusion runs many similarities with research completed by Dr. K Anders Ericsson, and his team over at Florida State with tennis athletes.

It was found that more elite level tennis players extracted key pieces of information about their opponent's behavior, which was then processed and shaped the decisions of the performers motor action. Studies on pilots also showed similar results.

The Conclusion:

Research shows us that humans move in tune with the environment, and their surroundings, which subsequently shapes how movement is then executed.

Practical Advice:

Create an environment that constrains golfers to produce specific movements that in turn helps improve that movement. One basic example would be to make golfers achieve a certain score, or better, on a hole before moving on to the next hole.

References:

Ecological dynamics and motor learning design in sports, authors Keith Davids, Duarte Araujo, Robert Hristovski, Pedro Passo and Jia Yi Chow.

Dynamics of skill acquisition: a constraints-led approach, authors Davids, Keith W., Button, Chris, & Bennett, Simon J. (2008)

Dynamical systems theory, and the whole constraints led learning approach was something that some students over at Texas State University thought it would be a good idea to create a video about, and they did a pretty good job.

Here is the link to the video - check it out:

<https://www.youtube.com/watch?v=4t2ww3gfKrg>

About Matthew Cooke



Originally from the United Kingdom, Matthew is the founder of 'Game Like Training Golf Academy'. The Academy runs full scale coaching programs for all level golfers, and educational programs for coaches looking to expand their knowledge on scientific learning principles. Clients spread from all over the United States, Europe, South Africa, and Australia.

Matthew is currently involved with research studies in expertise and expert performance with Dr K Anders Ericsson, and Len Hill PhD, and is collaborating with professors in motor learning, cognitive psychology, neuroscience, and professionals at the United States Olympic Association.

Matthew has written 4 workbooks that have helped hundreds of golf coaches, and players, in over 13 countries, practice, and train more efficiently. The workbooks give an insight, and practical examples, to the key characteristics of creating an environment that fosters learning.

Collaborating with the world's best golf coaches, and academic professors, Matthew aims to educate, grow, and give back to the golf community.

Learn more at
gameliketraininggolf.com