

A book report by

Paul Harris, OD

Available from Amazon

- https://www.amazon.com/How-We-Learn-Move-Revolution/dp/B09KDSQD9Q/ref=sr_1_1?crid=31Y0NXKCYNB42&keywords=rob+gray+how+we+learn+to+move&qid=1639846474&sprefix=rob+gray+ho%2Caps%2C75&sr=8-1
- And there is a podcast:
<https://perceptionaction.com/>

HOW WE LEARN TO MOVE

A REVOLUTION IN THE WAY WE COACH
& PRACTICE SPORTS SKILLS

ROB GRAY, PH.D.

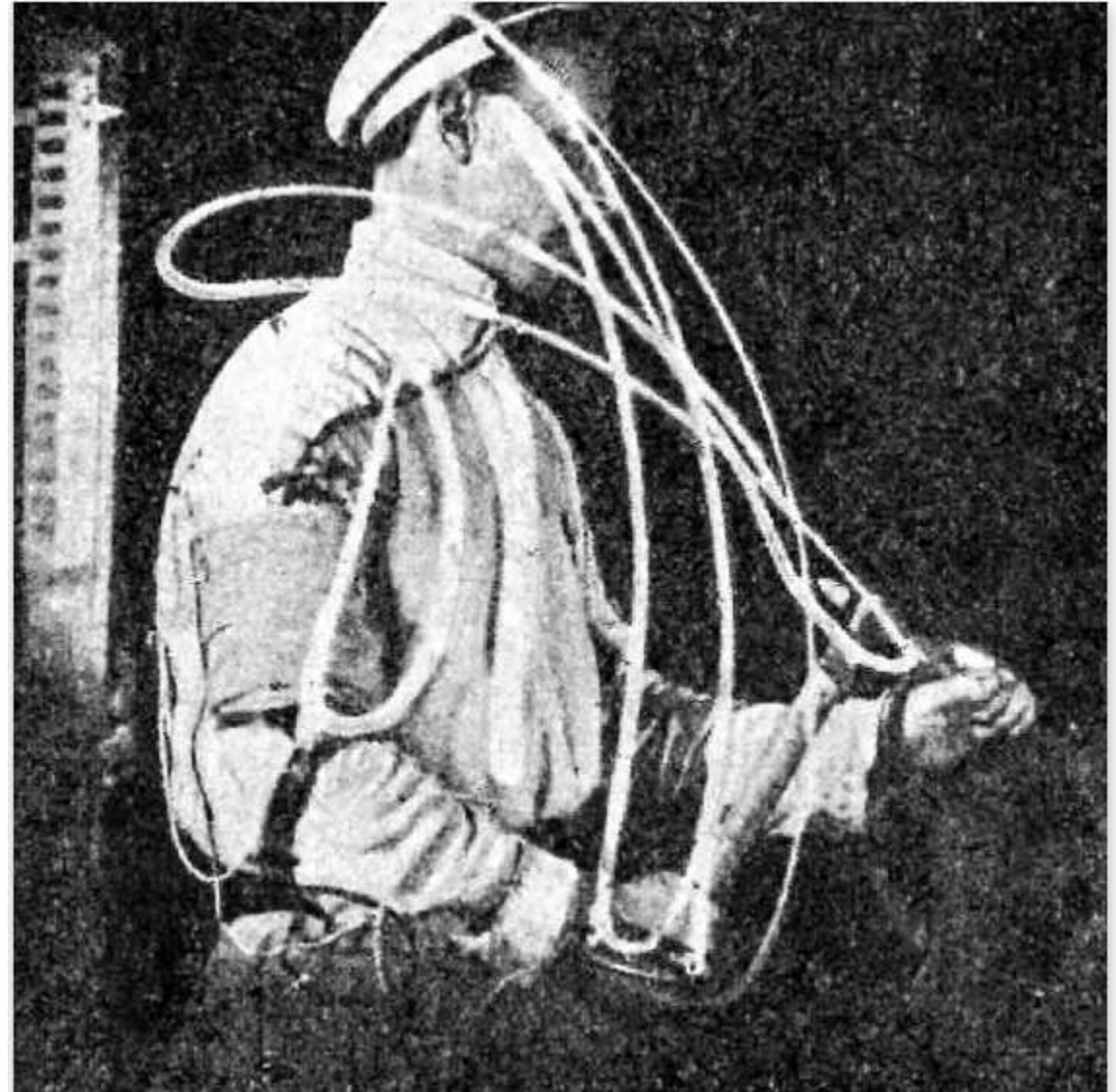
PERCEPTION ACTION CONSULTING & EDUCATION LLC

The myth of there being one right way

- John Wooden once cleverly proclaimed that, “The eight laws of learning are explanation, demonstration, imitation, repetition, repetition, repetition, and repetition”.
- Repetition is “the mother of skill”, according to Tony Robbins.
- Repetition is “the father of action”, according to Zig Ziglar
- Daniel Coyle, from “The Talent Code”, states that “there is no substitute for attentive repetition”.

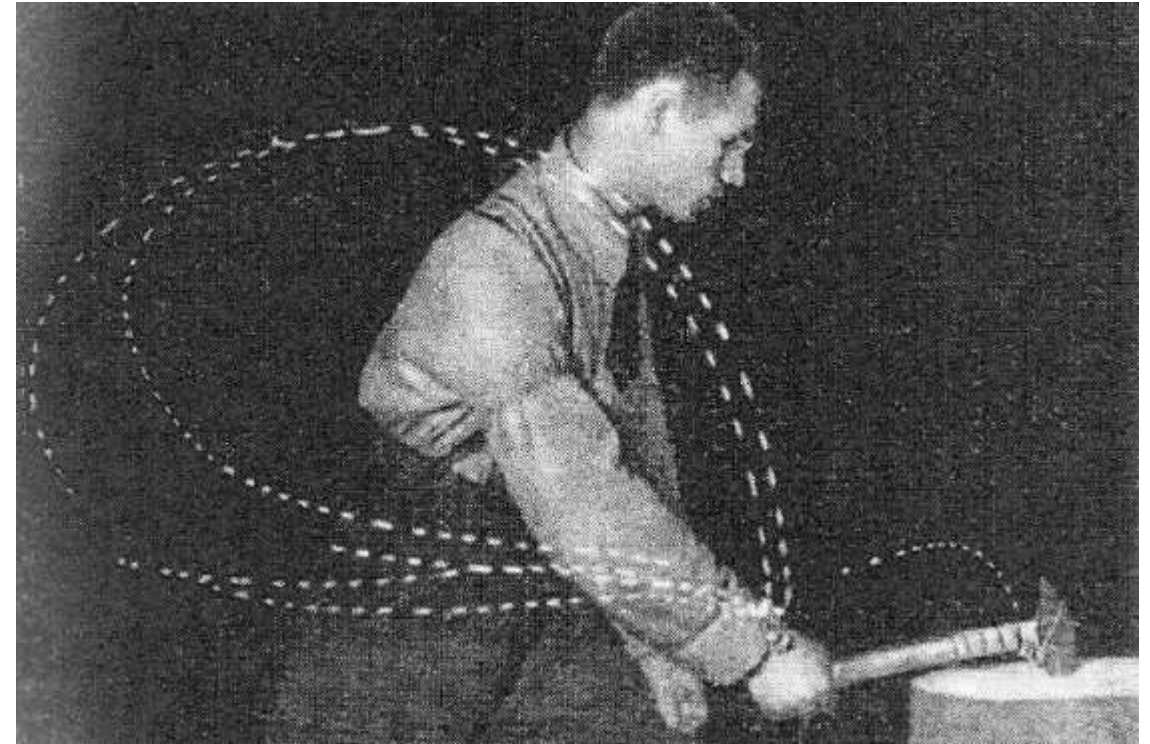
Nikolai Bernstein's Hammer

- Novices are all over the place.
- Experts seem to be similar with each hit.



Repetition without Repetition

- We repeat an action outcome but not by repeating the movement that produced it.
- We don't repeat our movements, but they are not completely random and variable either. They are shaped by the constraints of our environment (including our culture).
- The key to becoming skillful was not strict repetition. Instead, it was repetition without repetition – learning to produce the same outcome by using different movements.



Context Conditioned Variability

- Skillful movers in the same discipline do not all coordinate their movements in the same way – there is significant inter-movement variability between performers. Skillful movers do not achieve their goal by moving the same way every time - there is significant intra-movement variability within performers.
- Rafael Nadal, “You might think that after millions and millions of balls I’ve hit, I’d have the basic shots of tennis show up, that reliably hitting a true, smooth clean shot every time would be a piece of cake. But it isn’t. Not just because every day you wake up feeling differently, but because every shot is different; every single one. ... No ball arrives the same as another; no shot is identical.”

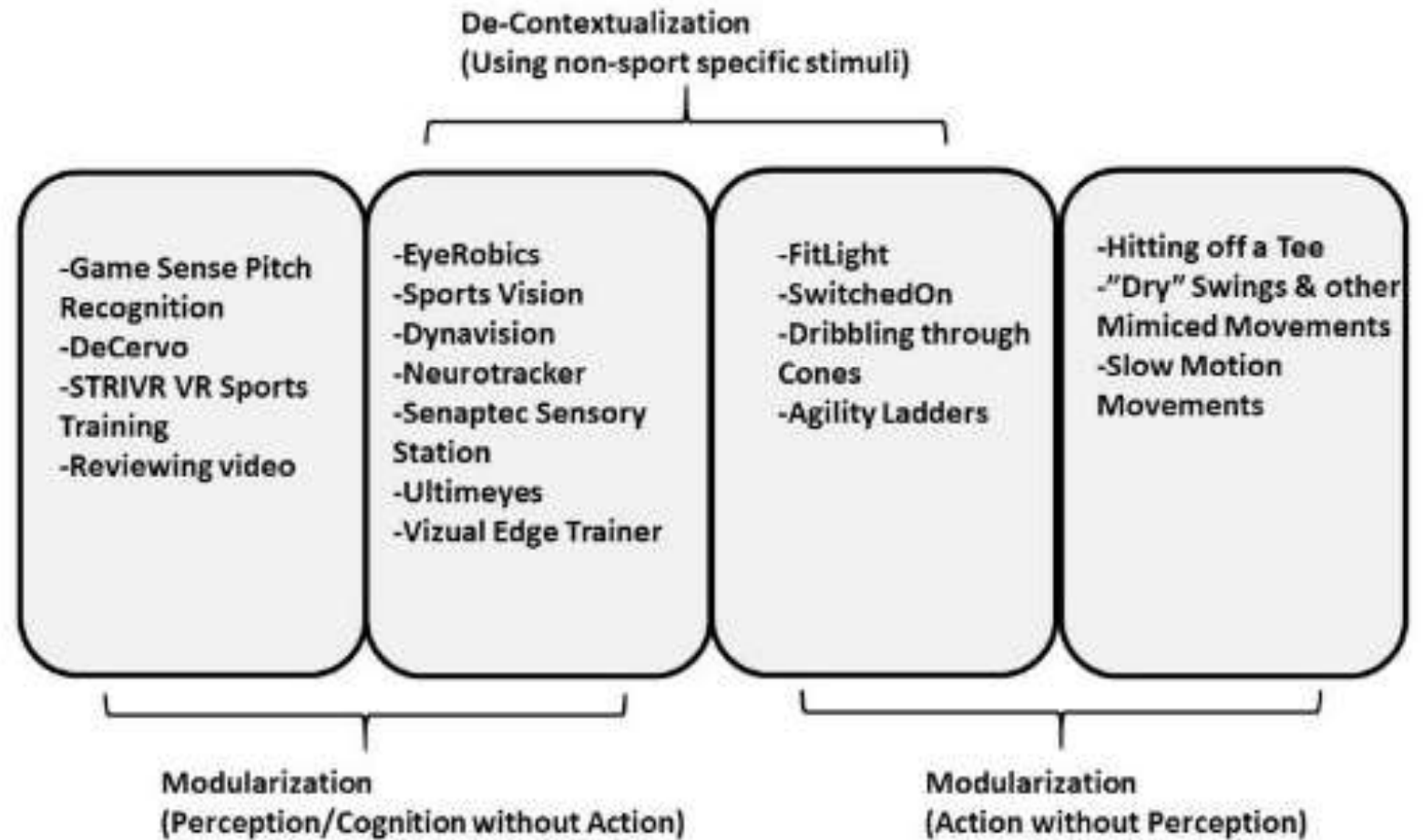
Variability begets Adaptability

- With variability comes adaptability! Being able to produce slightly different, variable patterns allows us to adapt to changes in our environment - both internal and external. If the problems of movement are always changing (even for one of the greatest tennis players in history), then we need to have multiple solutions.
- This adaptability through having multiple, variable solutions to achieve the same goal is a fundamental feature found throughout nature, termed “biological degeneracy”.
- Degeneracy occurs in a system when components that are structurally dissimilar can perform similar functions – they are effectively interchangeable.

Side Benefit: Injury Avoidance

- Variability is a beneficial design feature that allows us to adapt and keep achieving our goals. It also seems to help prevent us from getting hurt.
- ... this breakdown will occur when there is not enough variability in movement to allow for adaptation.

Traditional Sports Training



Self-Organization the Key

- Order and structure arises from the interactions between the lower-level components of the system, which results in perception-action coupling: our actions are directly controlled by what we perceive.
- Self-organizing systems are much more robust and resistant to errors made in any one part of the system. (Harken back to my Wet Mind paper and neural networks)

Karl Newell – Constraints Model of Coordination

- A constraint is something that eliminates certain possibilities or options for action.
- Constraints serve to exclude some actions. They reduce the degrees of freedom.
- Three types of constraints
 - Individual: height, weight, strength, speed, flexibility, etc.
 - Environmental: gravity, wind, temp, light levels, slipperiness of the surface, etc.
 - Task: factors highly specific to the skill being performed. (most of the rest of the book and this report).

Practical Uses of Constraints

- Freezing Degrees of Freedom: Bernstein proposed that when we first learn a new movement skill, we constraint ourselves naturally through a process he called freezing degrees of freedom.
- Constraining to amplify errors and take away ineffective movement: example, pitching on sand will help to magnify any landing problems with the feet. This makes the movement solution of the performer ineffective and encourages them to find a new one.
 - Take a slight flaw and make it larger and louder to the perceptual system of the performer. (Kraskin's approach to yoked prisms)

Practical Uses of Constraints

- Constraining to create variability and essential noise
 - We want to be adaptable and flexible so that we can use different movement solutions to achieve our goal in the face of ever-changing conditions.
 - Bernstein, “Dexterity is the ability to find a motor solution for any external situation, that is, to adequately solve any emerging motor problem”.
 - Moving skillfully involves coming up with new solutions to new problems not just repeating the same old solution. How do we learn to solve problems? By practicing a lot of different ones. In other words, by having variability in our practice conditions.

VR Training Batting to add Variability

- Factors varied: speed, pitch type, and location
- If you made contact on two 85 mph pitches in a row, the next one was 87 mph. If you hit two fastballs in a row, I threw in a curveball. If you could hit pitches that varied in their height they crossed the plate by 1 foot, I increased the variation to 2 feet.
- Batters in the high variability group did significantly better on all hitting tests, had a higher on base percentage in their senior session, and a significantly greater proportion went to play higher levels of baseball.

Embodied Perception

- The perception of the world is changing depending on our ability to act on it!
- When an athlete is more capable and performing well objects like a baseball, tennis ball or a basketball hoop look bigger. When they are struggling, they look smaller.
- This embodied perception approach to perception argues that what we perceive is not a true representation of 'what is out there' but rather reflects our ability to act on objects in our environment.

Gibson's Affordances

- In our environment, surfaces afford (that is they provide or supply) opportunities for action. Flat surfaces provide opportunities to rest, surfaces with gaps provide opportunities to pass through, hanging surfaces provide opportunities to seek shelter, and so.
- Perceiving affordances is to carve the world up in meaningful units of action rather than using the meaningless units of physics.
- Performers see pass-through-ability in a gap, tackle-ability of an opponent and hit-ability of a pitch. Perception of opportunities for action not just physical properties.

Why is our Perception Embodied?

- Our perceptual system is not designed to gather general-purpose information about the world or try to accurately reconstruct it inside our heads. Its purpose is to keep us in contact with action-relevant properties of the specific environment we are acting in. It is directly picking up information to support the selecting of goals, deciding between alternative courses of action and controlling our movements.
- Embodied perception supports action selection.

Finding New Movement Solutions

- A movement solution is not created from nothing. It is built on top of the perceptual-motor landscape the athlete brings to the first day of practice. Every athlete has both their own intrinsic dynamics and, most likely, some attractors that have been created through early experience.
- Every, single athlete you coach is different. Every single one. Coaching is not building a house from ground up. It is a renovation and expansion. Success requires designing practice that builds on each performer's foundation.
- The attractor landscape we create, is shaped by the constraints we face when practicing a skill.

Bifurcation (Ah Ha – Piaget Development)

- This type of learning, in which we switch to using a completely different coordination pattern that we never did before by creating a new attractor, is called bifurcation. The name reflects the fact that the performer is taking their perceptual-motor landscape and breaking it into new parts and regions of stability and instability.
- Doing this is usually accompanied by a large amount of variability as exploration of different ways to produce the new outcome is explored.

Shift (Piaget High Level-Learning)

- Shift:...instead of doing wild exploration like the first group, their learning involved more of a gradual shift towards the desired pattern. This type of learning is referred to as a shift, reflecting the fact that we are not completely restructuring our perceptual-motor landscape and making new attractors but instead just shifting and reorganizing ones we already have.
- Sort of like accommodation and assimilation of Piaget.

Keys to Providing Effective VT

- Be a designer or guide: An effective coach should attempt to design practice environments that foster exploration and promote self-organization rather than prescribing a solution to an athlete.
- Be informed and knowledgeable about the search process: They should also be observing practice to see if athletes are not taking the opportunities for action (the affordances they are trying to amplify) they have created.

Constraint Led Approach (CLA)

- Manipulate a constraint in practice in order to:
 - Destabilize the existing movement solution/attractor
 - Encourage exploration and self-organization
 - Amplify information and invite affordances
 - Provide transition feedback about the effectiveness of the search.
- CLA is trying to achieve adding *structured variability* to practice.
 - We want to allow the performer to explore and try different things, but we are pushing them to certain areas within the perceptual-motor landscape that we have identified as being key for an effective movement solution, whether it is keeping the kinetic chain intact when pitching or using a low to high stroke trajectory in tennis.

The Constraints-Led Approach to Coaching (CLA)

Goals

De-stabilize existing coordination solution/attractor



Encourage exploration & self-organization



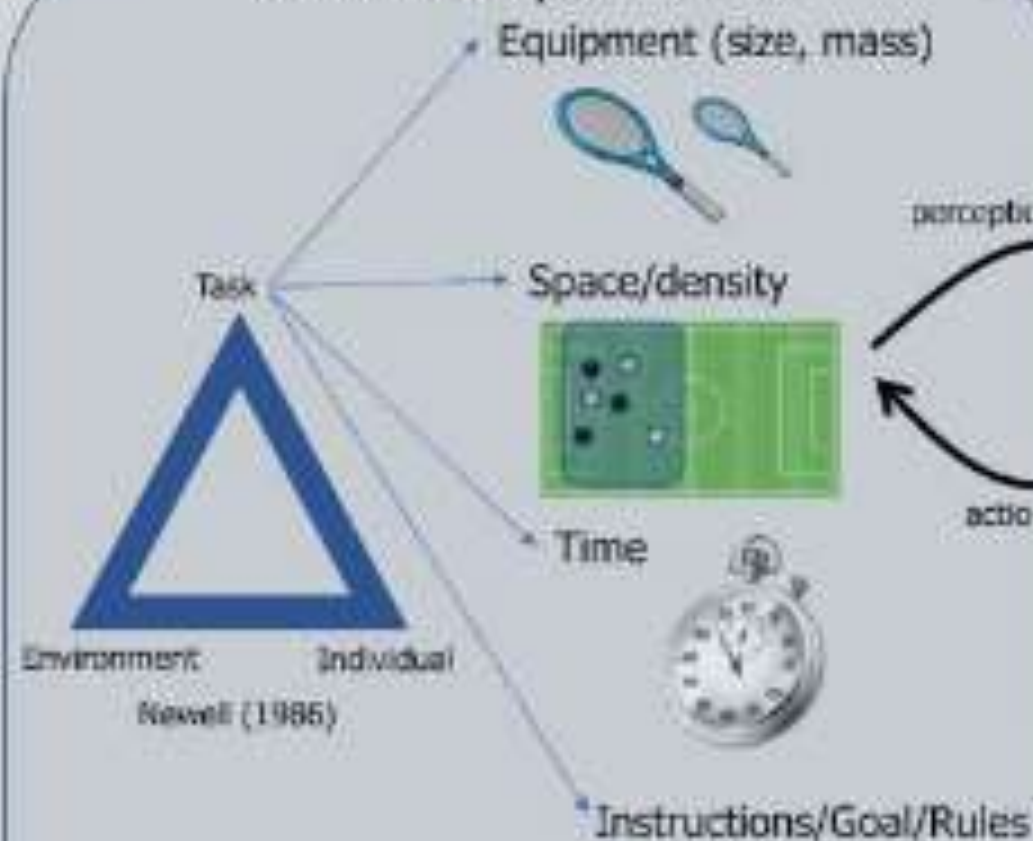
Amplify information & invite affordances



Provide transition feedback



Task Manipulations

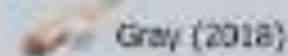


"Attack"

"Defend"

Results

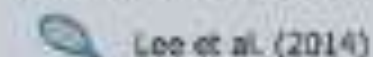
↑ Performance



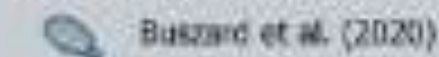
↑ Decision Making/Creativity



↑ Movement Degeneracy/Adaptability



↑ Functional Variability



Differential Learning

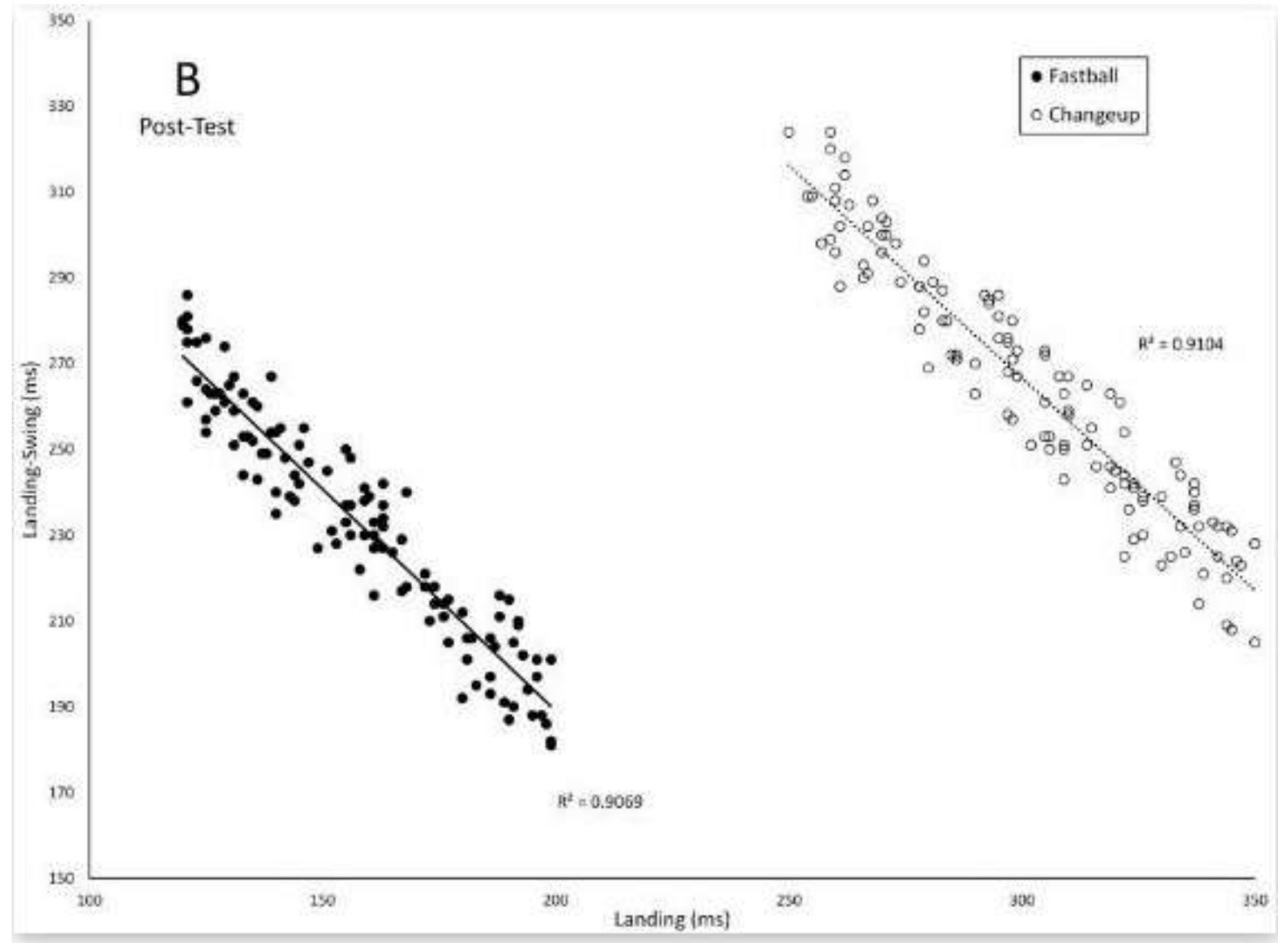
- Differential Learning has goals of destabilizing the performer's existing movement solutions/attractors, promoting exploration of the perceptual-motor landscape, self-organization, and creating variability in movement execution.
 - Add random variability to the practice environment
 - Perturb the system
 - Allow the performer to gain information about the solution space that can be used in future performances
 - Create the optimal level of noise for the person

<https://perceptionaction.com/comparative/>

Optimality as Adaptability: Developing Motor Synergies

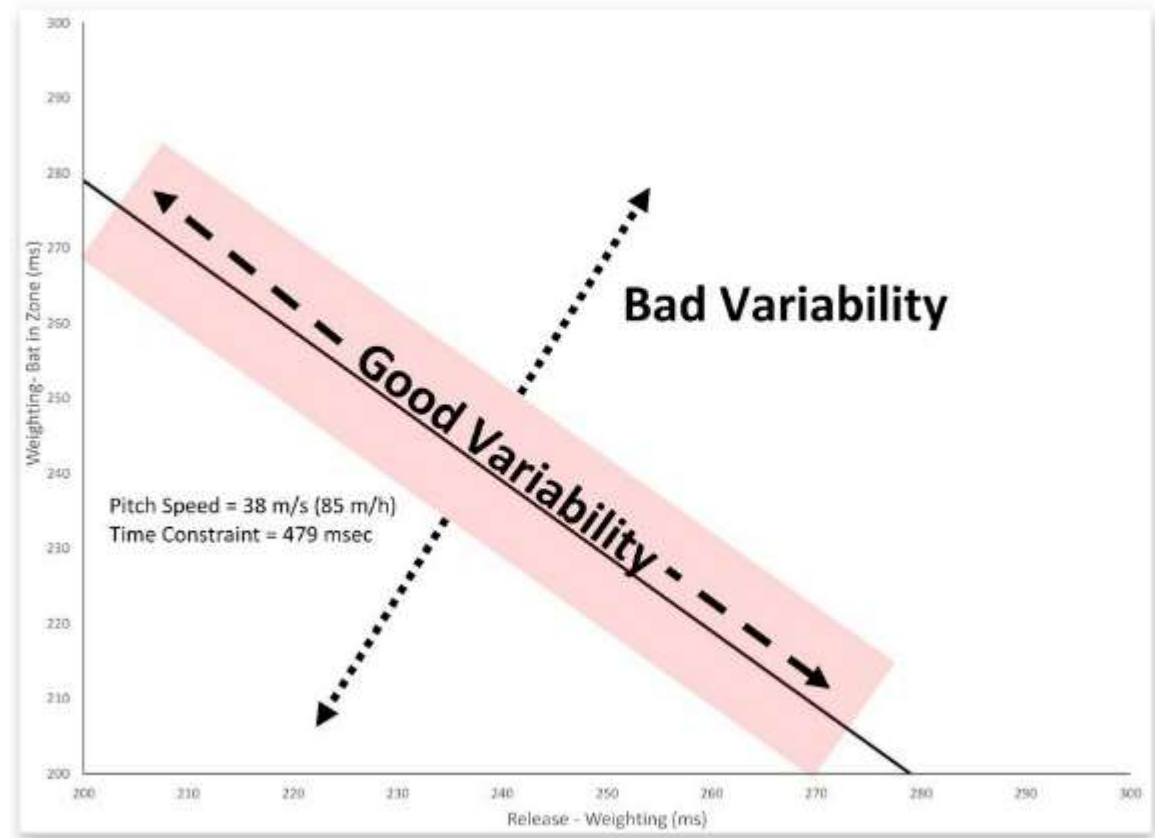
- An optimal movement solution is one that optimally satisfies the current constraints imposed on an individual performer.
- “Dexterity is not confined within the movements of actions themselves but is revealed in how these movements behave in their interaction with the environment, with unexpectedness and surprises”.

Motor Synergies

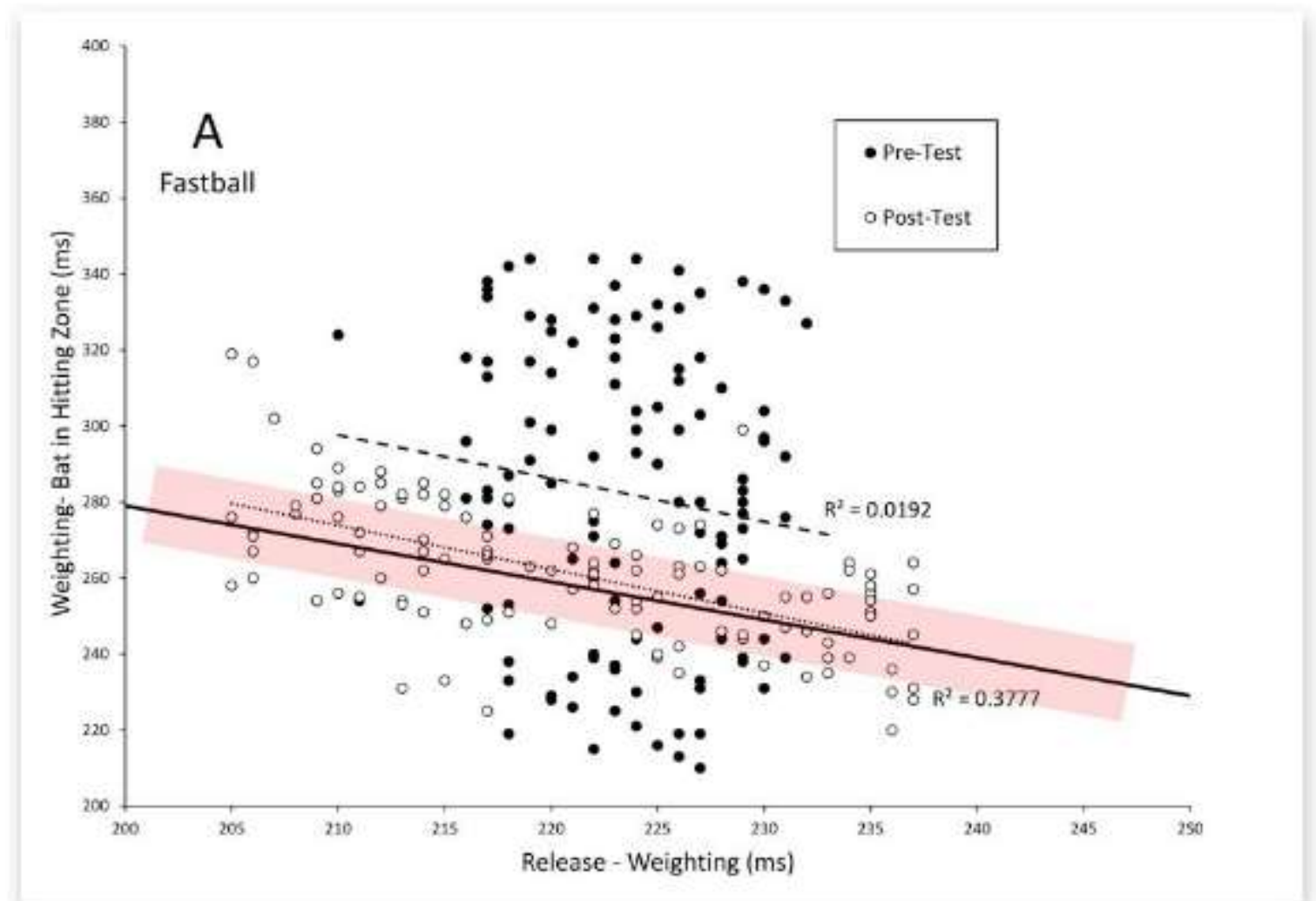


Variability in hitting an 85-mph pitch

- Variability is not noise to be removed but rather an essential part of skill.
- The time between the ball being released by the pitcher and the batter shifting weight to the back foot and (ii) the time between the back-foot weighting and the bat reaching the hitting zone.



Pre vs. Post VR Training



Creativity in Movement Solutions

- Changes in task constraints encourage exploration of different movement solutions. – Change from a sand pit to foam landing zone set the stage for the Fosbury flop and the Brill bend.
- 300 miles apart, didn't know each other, independently developed nearly the same technique.



Creative Solutions are not Ideas

- Creativity does not involve an individual first coming up with an idea in their mind and then sending it down to the motor control department to execute.
- Acting is not simply an expression of creativity. It is a central part of the creative process.
- Creativity is not an asymmetric process, occurring within the head of an individual then pushed out to the environment like a new product.
- It arises from a symmetrical, coupled interaction between the individual, task and environmental constraints faced by a performer.
- Creative solutions emerge when a performer is acting and searching for solution to satisfy the constraints of a task.

How can we promote creativity?

- Manipulate constraints (sports examples)
 - Cricket – Sir Don Bradman – averaged 99.94 runs per inning, 50% more than his closest all time.
 - Dismissed from service because of poor eyesight, slow reaction time in testing.
 - Practiced in basement with a golf ball hitting it off of a water-heater!
 - Small-sided
 - Less space (soccer, basketball & hockey)
 - Fewer people
 - One study with soccer development, showed that the fewer people and the smaller the space the more creative the athlete was. All else being equal:
 - 5v5 – 5 creative moves
 - 6v6 – 3 creative moves
 - 7v7 – 2 creative moves
 - 11v11 – NONE!

Other constraint variations

- Soccer
 - Playing surface
 - Shape of field
 - Kind of ball used
- General Statement: Coaching methods which encourage self-organization, exploration and variability are also those that seem to inspire creativity.

Making Practice Fun

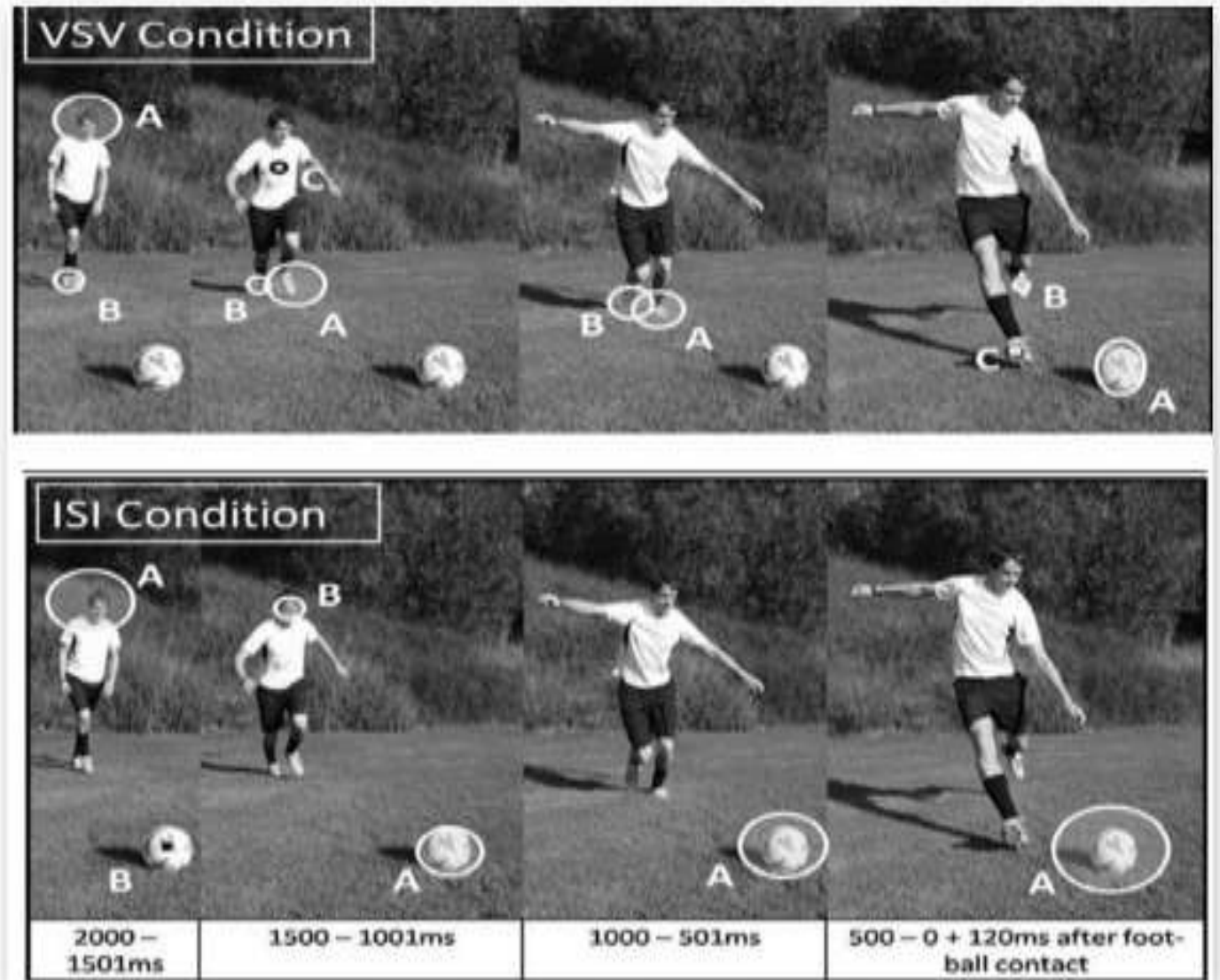
- Task simplification not decomposition
 - We want kids to learn to coordinate the movement of their feet, while keeping their eyes up, and deciding which way to go based on information they pick up from the movement of the person they are interacting with.
 - How to do this for soccer and not use lines of cones to dribble around?
 - TAG!!!
 - Having a coach try to tag players while they keep control of a ball.
 - Having two players control a ball within a designated area with one trying to tag and one trying to keep away.

Movement and Information are Coupled

- To make the movement easier for a new learner we scale down the skill while always trying to keep its basic structure.
- Some constraints to control
 - Slower speed
 - Shorter working distances
 - Smaller equipment
 - Retain similarity to what the end product should be.

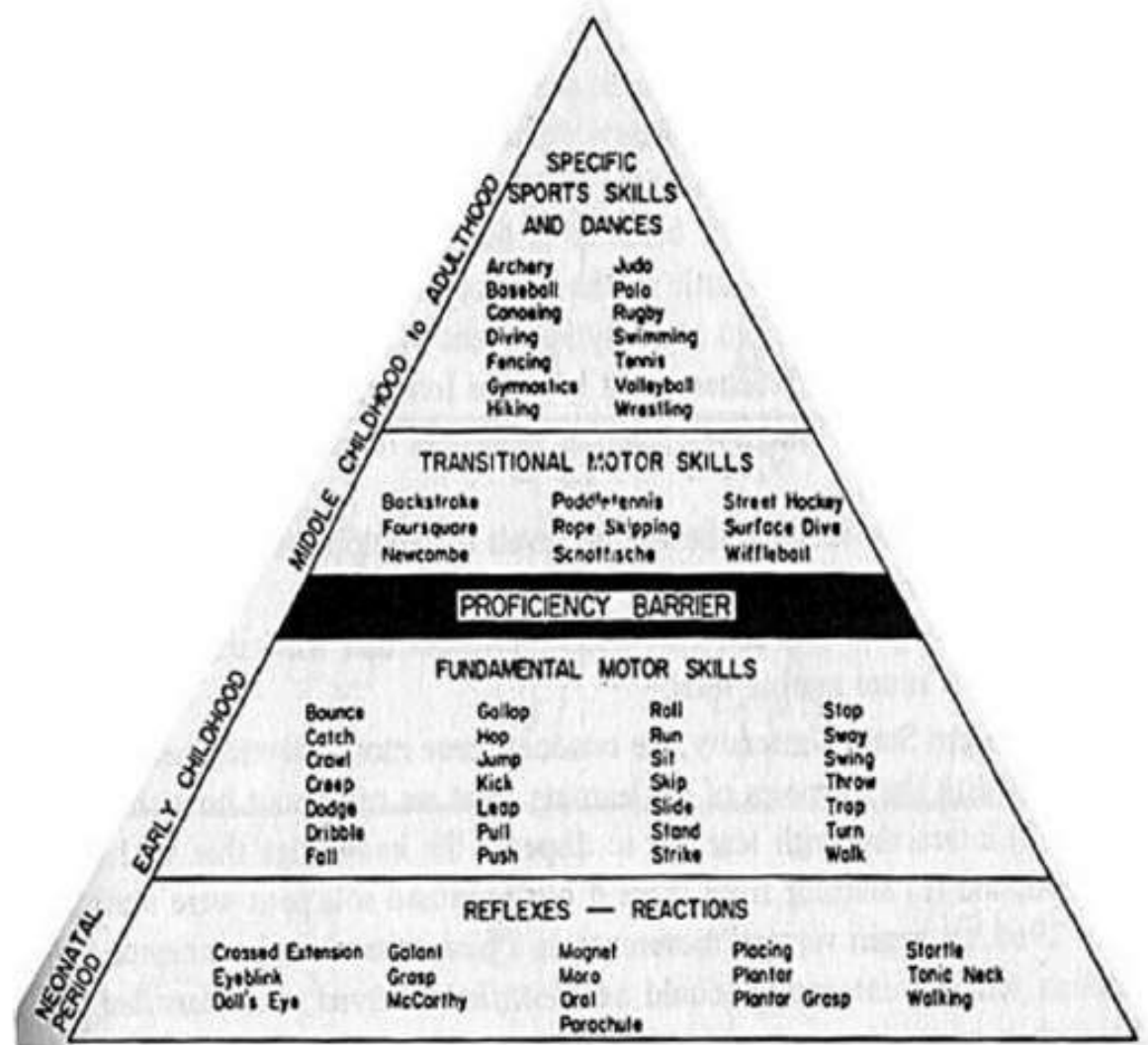
Coupled vs. Decoupled

- Gaze trackers were used with top level goalies.
- In the top part, the goalie was asked to say if the ball was going right or left.
- In the lower part, the goalie was asked to try to dive and stop the kick.



What exactly is “fundamental”?

- Assumptions: linear, deterministic relationship between fundamental movement skills.
- But this is not consistent with what we see with adaptive complex systems in athletes and with our VT patients.



Convergent vs. Divergent Problem-Solving

- When we assess “fundamental movement skills” we are looking for a convergent solution. Can the child solve this movement problem in this specific way?
- But this does not fit at all with this new view of skill as involving adaptive, variable, problem solvers.
- What we want to see are divergent solutions: how many different ways can you achieve this goal?

Donor Sports

- Athletes need to become versatile and adaptive movers before they can become expert athletes.
- Furthermore, they need to become attuned to affordances (that is, opportunities for action) in sports performance contexts.
- The key to becoming an adaptive mover and this attunement is the use of so-called donor sports which emphasize exploratory practice and guided discovery.
- Donor sport activities are ones which share some of the same athletic movements and affordances required for successful performance in the athlete's primary, target sport.

Is Automaticity Something to Hold up High?

- John Wooden, “The importance of repetition until automaticity cannot be overstated”.
- Norman Peale emphasized that:” repetition of the same thought of physical action develops into a habit which, repeated frequently enough, becomes an automatic reflex”.
- Celtics player Bill Sharman: “It’s a game of habit or repetition. It’s a reflex. The game is so quick you don’t have time to think.”

Within the traditional view of skill, thinking about or paying attention to what you are doing is a burden that must be lifted.

Adaptation is the Key!



Two views of what Ronaldo did.

- Traditional: “By 500 msec Ronaldo’s subconscious has interpreted Andy’s body language, worked out what direction the ball will go in, calculated its speed and trajectory, and then programmed his body to reach it at the optimum moment” and “it’s almost as if he is doing math in his head.”
- Assumption this is based on: that the information we pick up through our perceptual systems is somehow insufficient and impoverished. When Ronaldo is looking at the player and the flight of the ball, there is not enough information there for him to control his actions successfully. What he is perceiving needs to be interpreted, processed and enriched by the computer in his head for him to be successful in scoring a goal. This, of course, only gets exacerbated when we turn off the lights and take some of the perceptual information away.

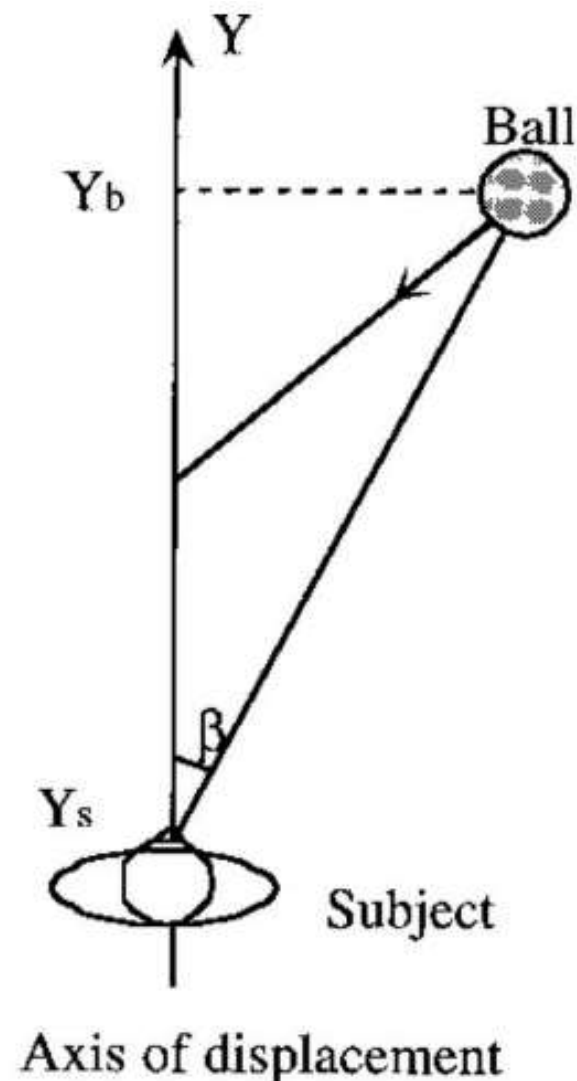
Two views of what Ronaldo did.

Direct Learning: Gibson illustrated, there is direct information that you can use to achieve your goal. Specifically, in this situation, there is an angle (β in figure 12.1) created between the player and the moving ball. If the player moves so that she/he keeps this angle the same (e.g., speed up if it starts to get bigger, slow down if it gets smaller), they are guaranteed to arrive at the right place and time.

<https://perceptionaction.com/ronaldodark/>

$$\ddot{Y} = \alpha \dot{Y}_{req} - \beta \dot{Y}_{cur}$$

$$\dot{Y}_{req} = \frac{Y_b - Y_s}{TC}$$



Direct Learning

- They are not really computing or predicting anything.
- They are not relying on stored memories of plays they have made in the past.
- They are just adjusting their movement in response to information from the environment.
- They are adapting to their environment, establishing a beneficial relationship with it, not acquiring something from it that allows them to be disconnected from it.

“Learning is about attending to things, rather than acquiring the knowledge that absolves us of the need to do so...” – Tim Ingold

Direct Learning (Jacobs & Michaels, 2007)

Experience-related change in the performer-environment relationship via 3 possible changes to information-movement control law

Information (Education of Attention)



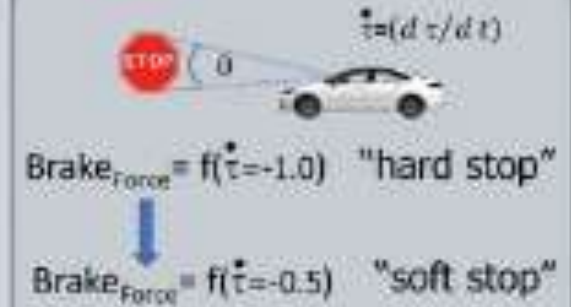
Change to using a more useful, specifying information source for controlling movement

Movement (Education of Intention)



Change in the intended goal action (affordance) or the intended movement parameter to be regulated

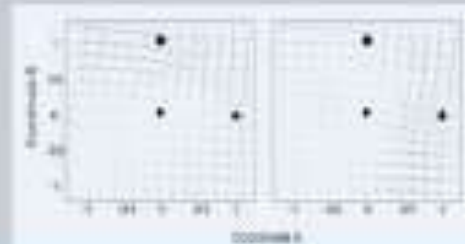
Calibration



Change in the values of the parameters used in the information-movement control law

Information for Learning

Higher order information which indicates the changes that need to be made to reduce non-optimalities in the information movement control law (see also Newell's "Transition Feedback")



perceptionaction.com



Summary

- The control of actions can be explained much more simply, more parsimoniously, as the establishment (and adaptation) of information-movement control laws in which the performer directly picks up some action-relevant information from the environment and uses it to regulate their actions. No need for prediction, information processing or assessing memories of previous actions.
- Skillful behavior is not rote, repetitive and automatic. It is adaptive, responsive and intelligent. We want to develop skills not just habits.
- Skillful behavior is intelligent and reactive to changing constraints both in the short and long term, involves an element of improvement, is concerned with the how –whether or action is conducive to achieving our goal.

Representativeness

- To what extent are athletes using the same information, performing the same types of movements and looking in the same places in practice as they do in competition?
- Research suggests this issue of representative design is not only critical for learning the skill, but it also may be important for injury prevention.
- An important example of this is how unplanned and unpredictable movements are incorporated into practice.
- As a consultant, one of the comments I find myself making a lot when observing practice activities is: “well that was a nice dance recital when does practice start?”.

A Final Thought

- Frans Bosch likes to say: “The body has very little interest in what the coach has to say”.

Bosch, F. *The Anatomy of Agility*. HHMR Media

References & Thank you

- -For an alternative access to links please go to:
<https://perceptionaction.com/book>

Paul Harris, OD

1552 Forrest Avenue

Memphis, TN 38112

+1-443-857-3925

Paul.HarrisOD@gmail.com