"Watch The Ball Trajectory!"

The full Game Based Approach

And an introduction to the *The Inner System* of Technique

N.J. Mol

Amsterdam, November 2016 ©

“I am feeling like a million, though I haven’t got a dollar, shilling or sue, still I am feeling like a million and I want to get it over to you”

“I am feeling like a million though I couldn’t buy a collar, a necktie or glove still I am feeling like a million; Is it you? Is it me? Is it love?”

Dick Jurgens and his Orchestra – Singer: Ronnie Kemper

Anja

A picture says more than a thousand words. A video clip appears because a beer brand decides to show an *exciting* image of tennis[1].
The DemoClip[2] – The subtle change of the game idea of the perspective from the *spectator* to the perspective out of the *ball* itself.

[1] From a tennis match between Roger Federer (red) and Rafael Nadal (green) http://www.thefwa.com/site/corona-perspectives?c=sotm
[2] https://www.youtube.com/watch?v=JuD4cLlt5ik


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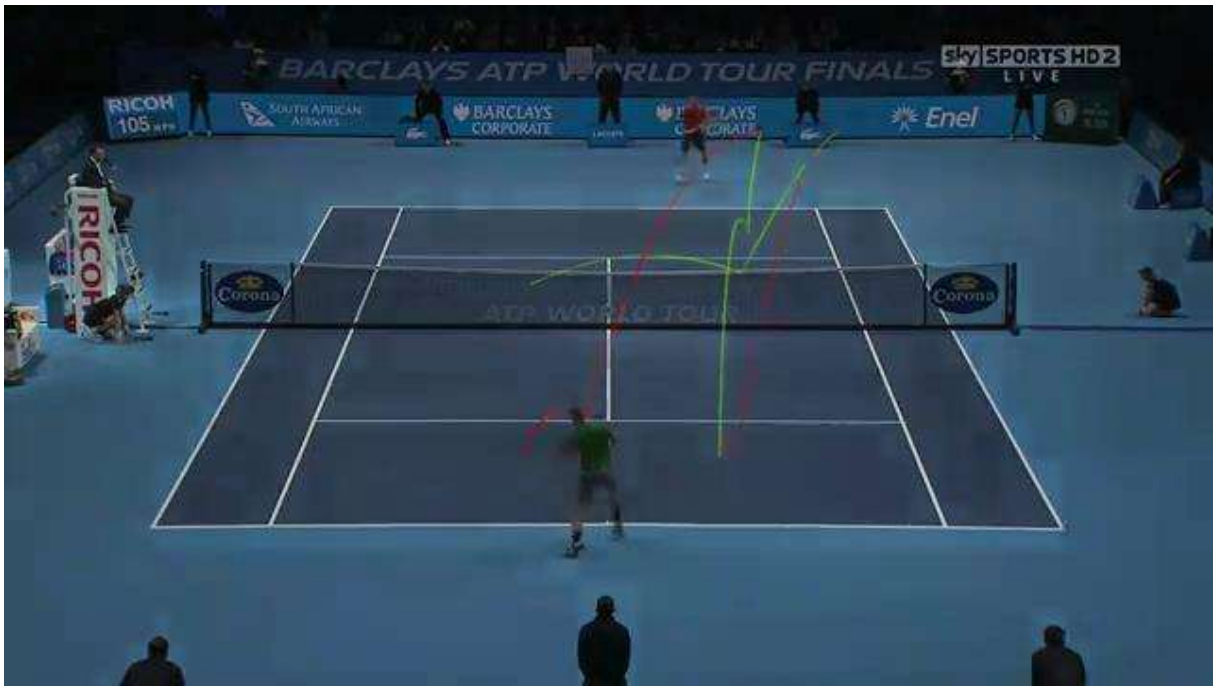
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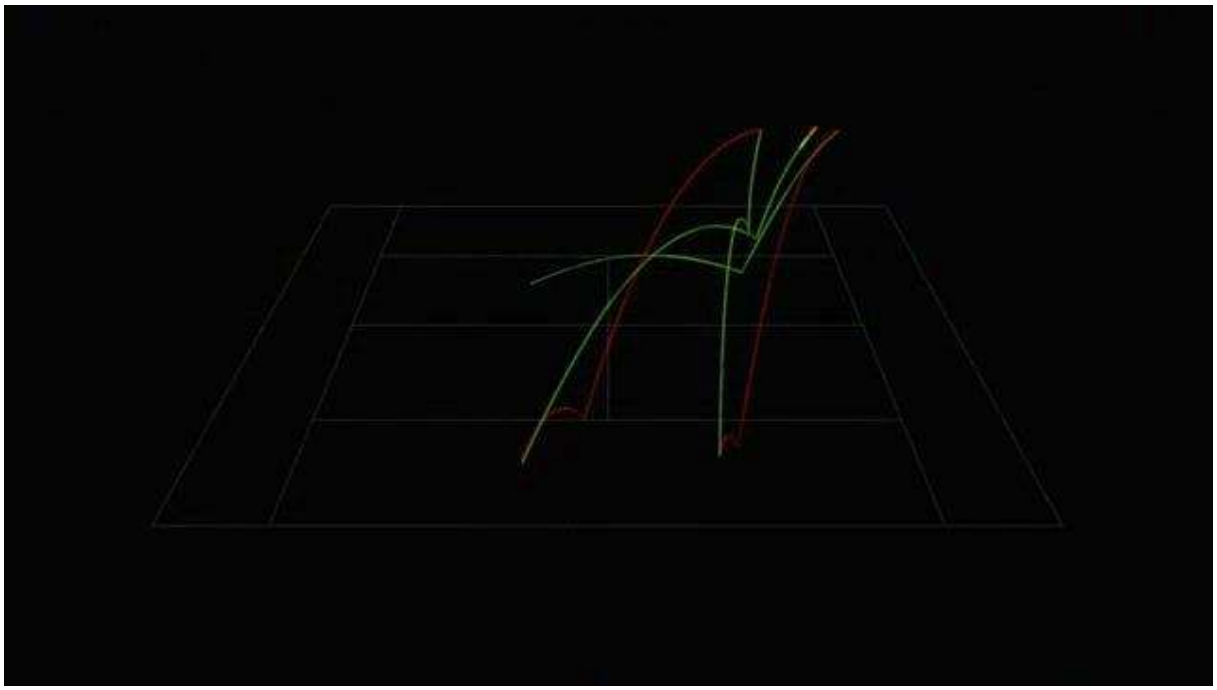

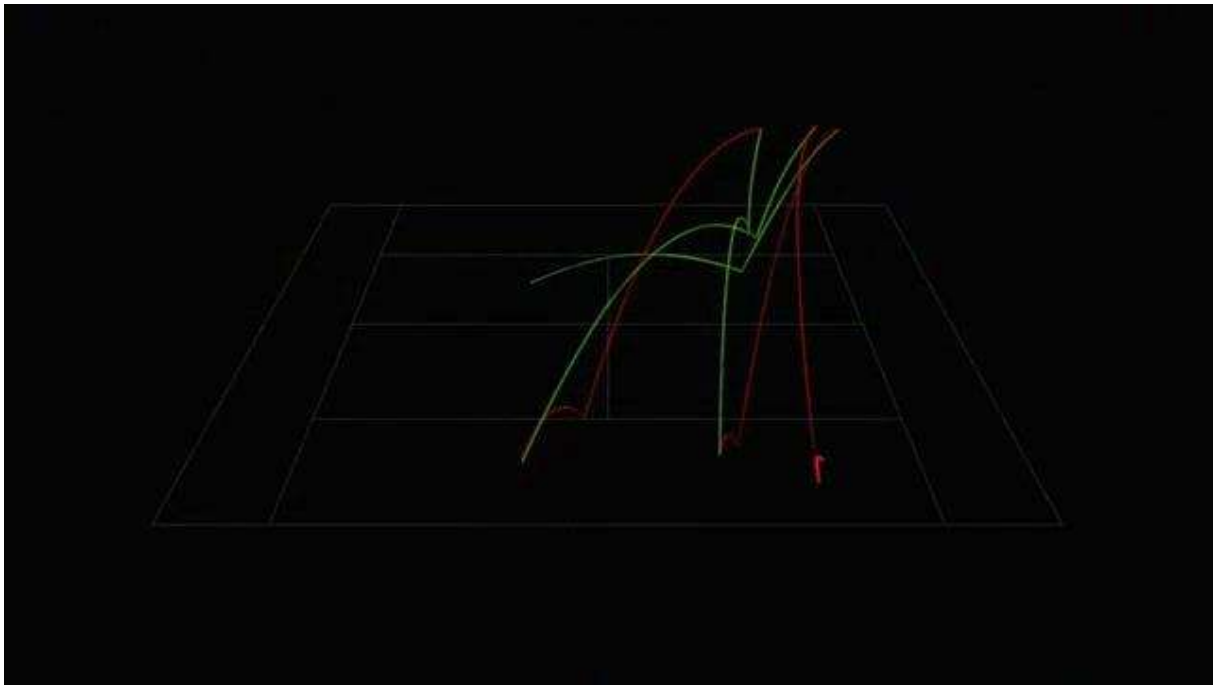

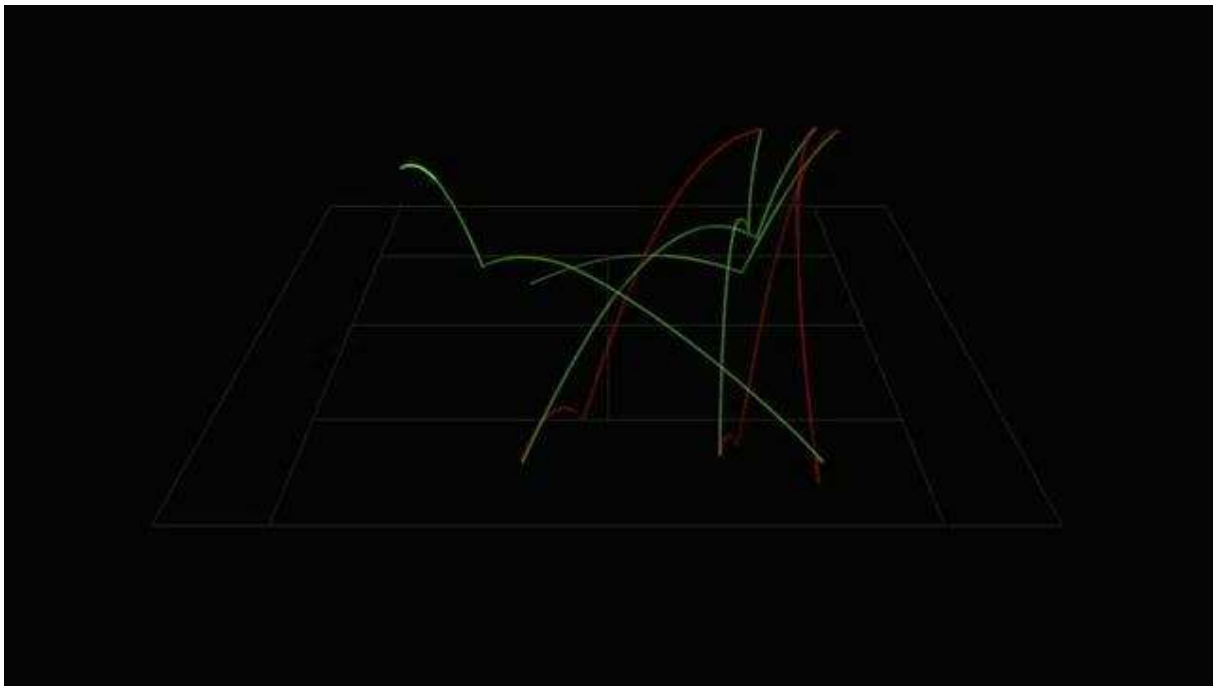

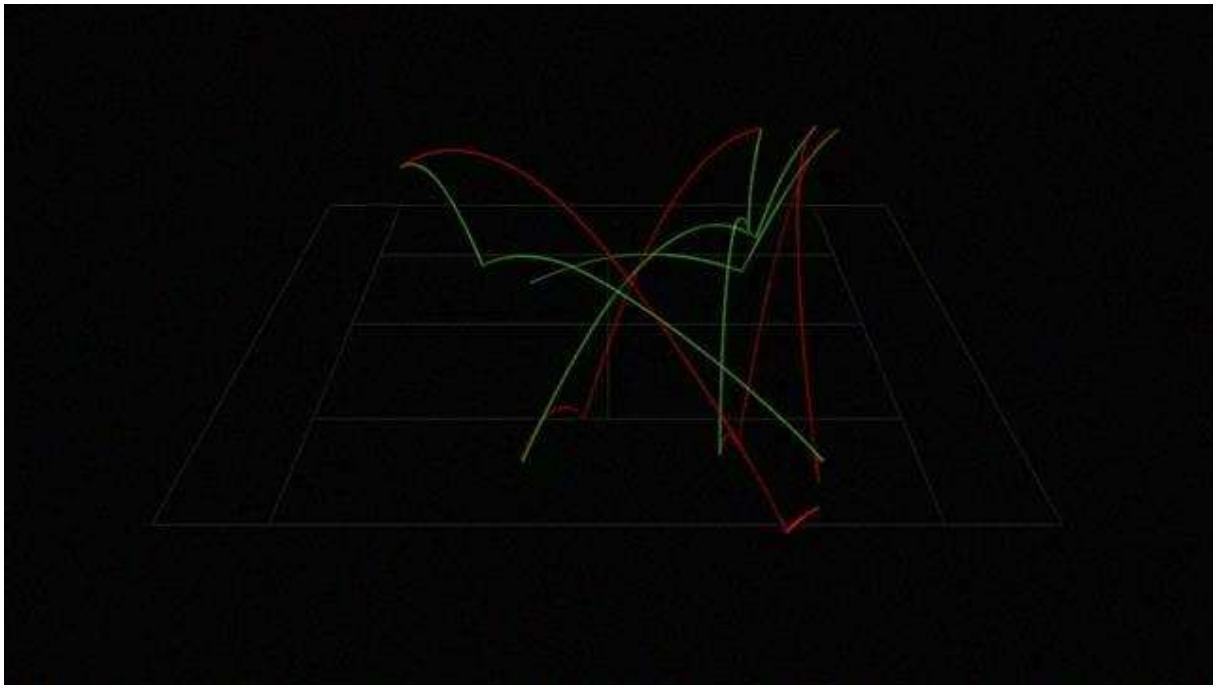

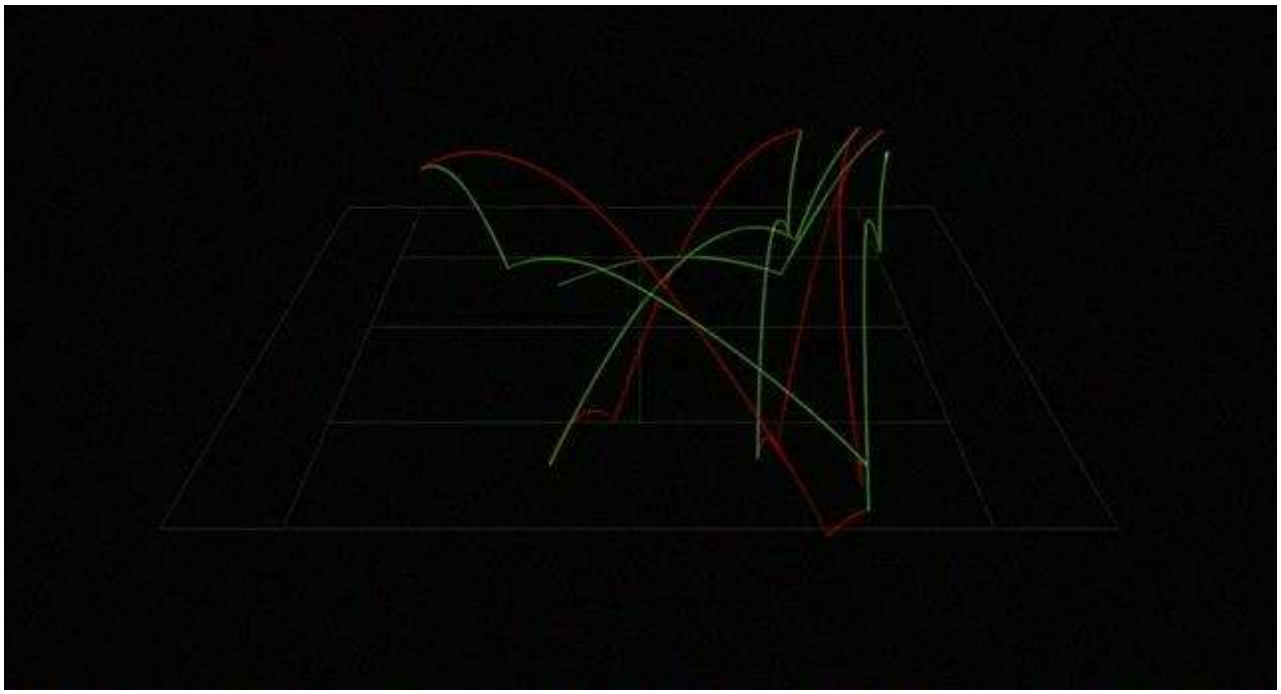

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"CHAPTER II -SOME COMMON FAULTS

One of the most important things in tennis is to keep the eye on the ball. Nine players out of ten lose sight of a ball shortly after it crosses the net. It is essential to watch it until it comes in contact with the racquet. Most players, when they should be watching the ball, are either looking at their opponent or at the spot on their opponent's court where they wish to place the ball. The player who takes his eye off the ball, if only for the fraction of a second, may in that short time miss the opportunity for hitting it clean, i. e., in the center of the racquet. This applies to every shot in tennis. It is an excellent thing while playing to repeat to one's self over and over again:" Eye on the ball," "Eye on the ball.". "[3]

The mantra "*Watch The Ball"* is the most used statement in tennis. In retrospect I dare to say it has ravaged tennis instruction. This book will completely appoint the phase of tennis in which this mantra is used. By doing so the conclusion will be that it was the wrong statement for ages. Verbally it came close to the right statement. Substantively it belonged to the other end of a spectrum. After reading this book you will never be able to go back. You will only be able to shout: "Watch The Ball Trajectory!"

"Watch The Ball Trajectory!"

N.J. Mol – Amsterdam, November 2016 ©

[3] How to play tennis; J. Burns; new ed.; The McMillan Co. (1931)

Preface

Every sport discipline must be able to appoint its tasks. Tennis as well. As a sport you have to legitimise yourself. What is your basis of existence? These are the first questions a sport has to answer. The most essential question concerning this issue is about the game itself. What is the game idea? What are the exact tasks for a player? These questions are as relevant as one decides to give instruction to players. Which processes do the game impose on a player?
The essences, the ultimate premises, for the tasks flow from appointing the game idea of the sport at hand. One has to appoint the tasks out of the game and in no other way. It is the obligatory mission of every sport union to appoint the game idea and the corresponding compelling processes. That must be the approach. Out of the game. The Game Based Approach.
So the Game Based Approach is not a voluntary choice. It doesn't make sense to teach a player everything about the ball. He will only benefit when his knowledge about the game is increased.

I began a quest to the full explanation of the game of tennis out of the obligation of the Game Based Approach. It wasn't there yet. Parts of the Game Based Approach existed but were not complete. A very essential part wasn't appointed at all. I call that the Actual Tennis Action. The positions of the existing parts gave reason to misunderstandings.
I have appointed all the essential tasks in one simple and basic model. The model has been appointed as a complex system[4]. This is in big contrast with most all of the explanations being linear. With this model we say goodbye to tennis as a form of art. It is brought back to the craft it should always have been. By appointing it as a complex system tennis can now be seen as a very difficult sport which can be controlled by working very hard.

This book is the result of a search in tennis from a passionate teacher. A teacher who proactively has to explain the field of tennis and appoint it as maximal as possible. The gained knowledge has to be written down in order to create a circle of progressive insights. The final goal is to determine the ultimate truth or trying to get as close to that goal as possible.

The common grounds of all the new insights are rooted in the fact that a ball is glued to its ball trajectory. I remember the time I was looking for evidence for this. I really struggled to prove it until I realized that it was a fact. That I didn't have to prove anything. Every moving ball creates a ball trajectory. It is a basic principle. Here I want to invert the burden of proof. If you don't agree than prove to me that a moving ball doesn't have a ball trajectory? If you look at the DemoClip I ask you the question: "How can you not see a ball in relationship to a ball trajectory?". If you have seen the DemoClip there is no way back. Is there?
While working on this book I had to imagine the Game Action without ball trajectories once more. To locate some arguments from the *old* situation. Where the two views exactly differ from each other. I can honestly say that was a tough job. I have incorporated the Game Action in such a way that I can hardly imagine how others still see it.

[4] https://en.wikipedia.org/wiki/Complex_systems

How can I imagine that someone sees an incoming ball and then doesn't perceive that in relation to a ball trajectory. That I follow the ball and only the ball. That I in meanwhile, in accordance to the *old* Tactical Tennis Action[5], judged the game situation and came up with an idea for an outgoing ball with an optimal Game Intention[6] (In no way an outgoing ball *trajectory*!). Let's assume the outgoing ball is a cross-lob over an approaching opponent. Than I have to see the ball approaching me and suddenly think *wow* there is a beautiful contact point from which I can make a nice lob. And then I just aim over my opponent to a place deep cross-court without ever imagining a ball trajectory? If that was the case than tennis is really an art. I can't get that into my head anymore. Even if it will be proven that no pro player uses ball trajectories than the idea to visualize ball trajectories is the best assumption one can have about what should happen. If no pro player is doing it there would be a lot to gain. But unfortunately I think that elite players do this already and that it is only never appointed somewhere.

"Watch The Ball Trajectory!" is written as "the missing link" in tennis and is supposed to create a revolution in the working field of tennis. Not for the players. It has to become the leading benchmark for all future proposals, methods and thoughts. Already existing methods must be rejected if they are not in accordance with the Game Action. "Watch The Ball Trajectory!" prescribes a mandatory review. Permissiveness must be rejected. That will lead to the most effective methods which approach the truth as much as possible. And once these methods exist the player can be confronted with them. The player must only possess the ambition to improve. The knowledge must be at the side of the coaches and the managers who have to make it possible. Within my code of ethics they have an ongoing assignment to look for the most effective methods to help players. From that knowledge they also have the task to reject methods which are not conform the Game Based Approach. The description of the Game Action will lead to the rejection of many existing methods.

[5] Chapter 1.1
[6] Chapter 1.6

We, tennis players, consider tennis not to be a regular game. No, it is art! Well, hang on to that. Especially in passionate discussions with your friends. I do so too. However the biggest revolution my revelations caused is that the teaching of tennis is brought back from a form of art to teaching as a craft. Appointing tennis as an art has always been a great excuse for coaches to hide behind. By appointing it as a craft many responsibilities will have to shift towards the coach. From now on the coach will have to deliver a huge amount of artisanal labour. He no longer can blame it on the player. The player wants to reach the top. We don't have to doubt that.
In retrospect this is the only disappointment the new revelations have given me. Appointing tennis mastery from a difficult to grasp, a bit hazy, artistic attitude has just more charm than appointing tennis as a result of craftsmanship in a narrow strict framework. Tennis is no longer dependent on incidental special insights. From now on you can train it in a full rational way.
There for this book will never be a success. How true it will appear to be. My theory is not hazy and it says that you have to work very hard in an artisanal way. We rather don't want to hear such messages. We prefer to hear that there is secret back door and that we can become champions while sitting in a comfortable chair. That is why mental methods do have success stories. We prefer to hear that we can eat anything as long as we take that special pill. Instead of suffering on a treadmill.

All my life I have been an autodidact. I learned to sail and play chess out of books. But I followed some *real* educations as well. The end of these studies however were the beginnings of more extensive self-studies. So after the training at the Royal Dutch Lawn Tennis Association (KNLTB) I also continued to study to get a complete image of the essences of tennis.

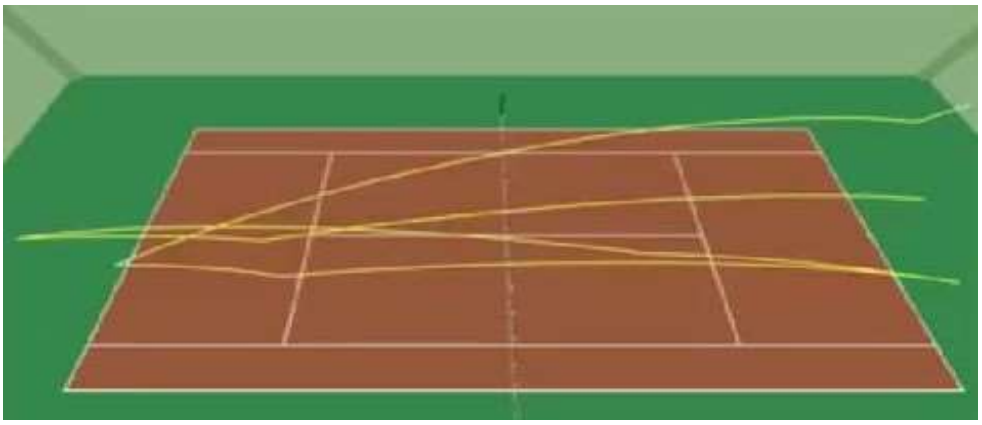
"The quest to understand the nature of sport expertise has lead researchers to explore the characteristics of superior performance."[7]

"Knowing what essential attributes distinguish skilled performers from their lesser skilled counterparts provides a principled basis for determining what types of practice are most likely to be beneficial for enhancing the development of expertise. In this way, the knowledge generated by sport psychologists from expertise research can be of immediate relevance to the key issues of training, testing and talent identification routinely faced by sports scientists, coaches and practitioners."[8]

A personal drive was my motivator but especially my code of ethics in being a teacher. If you want to teach anything to someone you have to do your utmost in gaining knowledge concerning the teaching process in the work field you want to be active at. I have been a professional dancer and dance teacher for decades. I have trained thousands of students and dance teachers. Besides that I did scientific research and developed new dance methods. I am a scientist. I have the curiosity. Not satisfied with an easy answer. I combine that with a side which a lot of scientists don't have. I am not only researching but I want to be able to perform the outcome of the research myself. So I am doing participatory research in my own findings. Findings have to be translated in practical useful methods. A lot of scientific research does not translate anything to the level of the work floor. That is also the conclusion of Richard Schonbörn. One of the pioneers in tennis. This book is a mixture of scientific revelations and very useful applications based on these revelations.

[7] The role of the quiet-eye period and the bereitschaftspotential in arousal regulation and motor preparation for performance of a self-paced skill; D. Mann
[8] Williams, A.M., Davids, K., Garrett, J.; Visual Perception and Action in Sport

I never planned to write about my findings. I thought as a newcomer that everything was already known in tennis after merely 100 years of existence. I only wanted to improve myself. I didn't know that I would discover anything worthwhile.



So after my official training I had to get better in tennis. I was triggered by a few incidents and findings. There are a few. I think it is important to mention almost all of them.

- From the beginning I read everything about tennis what I could find. I detected a huge pile of tennis literature (?!). From very amateurish to a lot of scientific articles.

"Scientific articles on tennis have increased dramatically over the years. In fact, several tennis-specific editions of scientific journals have been dedicated to tennis in recent years. This includes the British Journal of Sports Medicine (2006, 2007), the Journal of Science and Medicine in Sport (2003) and the Strength and Conditioning Journal (2009)."[9]

"Wenn man sich in der neueren tennisspezifischen Weltliteratur umschaut, stellt man fest, dass es nach wie vor wesentlich mehr Bücher gibt als über das Training derselben."

"Das größte Problem im Tennistraining bisher ist die Tatsache, dass die meisten Trainingsmethoden oder Trainingsformen recht wenig oder in Einzelfällen sogar überhaupt nicht im Zusammenwirken zwischen Theorie und Praxis entstanden sind. Sie sind merkwürdigerweise sehr oft realitäts- und damit matchfremd, obwohl sie fast ausschließlich in der Praxis kreiert wurden, was uns zu denken geben sollte. Dabei war die Theorie viel zu oft sehr praxisfremd und die Praxis theorielos."

"Somit ist es an der Zeit, sich mit dem Lernen und dem Training ausgiebiger zu befassen und zu versuchen, ein System aufzustellen, auf dessen Basis man die tägliche praktische Arbeit viel produktiver und erfolgreicher gestalten kann."[10]

Just like Schőnborn I noticed that just a very small part of the huge pile could be used by the player right away. Most of it had to be translated by a coach first before it could be used by a player. The same applies for most leading biomechanical research. Most scientists have their roots in one scientific discipline and do research in many different sports. You can feel that they don't play the game themselves and that they appoint the game naively from the perspective of the spectator.

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[9] Paul Roetert & Paul Lubbers; The role of sport science in coaching education; ITF Coaching and Sport Science Review 2011; 54 (19): 5 - 6

[10] Richard Schönborn - Tennis Techniktraining 4de editie 2012 - Einleitung

- I was confronted with a lot of colleague teachers who only blamed the students. The student is lazy or he doesn't understand it. My long term opinion is that it witnessed the incompetence of the teachers. Most of the time I think the teacher is what he blames the student. At least it was my goal to take the blame away from the student. You must have done so much as a teacher before you can blame the player.
In my opinion most mental methods also blame the students. It has always bothered me. In this book I will make it very clear that it was the direct consequence of the incompetence of the teachers and not the players. Incompetence to appoint the tasks fully and truthfully. I knew from the beginning that nobody can stare at just the ball for a long time. Only if a coach teaches you to look for information, which is truly essential, one can maintain to do that. I always wanted to strike back. With this book I finally achieve that goal.

Image: Roger Federer after the saccade (jump of the eye) to an incoming 35-40° round ball trajectory. He creates, with consistency as a starting point, an outgoing ball trajectory just after the highest point after the bounce in the downward path of the ball trajectory (2nd tempo). Like a lot of pro players. He allows the ball to come to the perception of the intersection point of the two curves. From there Roger has visualized an outgoing ball trajectory and especially the initial phase of that trajectory. The initial phase is the only time he can influence the outgoing ball trajectory.

- It also surprised me that colleague teachers didn't execute the model we learned during the, Game Based Approach based, education to become a licensed teacher. When I asked questions about important parts of the education program it soon gave problems. Everybody could recall names of the different grips. But questions about when to change a grip were a lot tougher. The *four-in-one principle*[11] was known but the *scheme of Gabler & Schrade*, the *three attention points* or the *four basic tactical principles* were far gone. The same applied to the tennis action. The tennis action, the essence of our training, wasn't standby. How was that possible?
I was confronted with teachers who lost their knowledge in a few years' time and saw that their lessons were filled with *conventional* exercises they probably received when they were players. In addi-

[11] The 4-in-1 principle contains the dynamic relations between 1.Grip 2. Contact Point 3. Arm action 4.Body position.

tion it struck me that their last day of the education was the last day of their self-study. I also felt deficiencies in the training but the massive scale of this decline also said to me that the education wasn't considered close to the truth.

- I have seen a lot of tennis academies at work. They all show the same structure with their 14-16 years old talents. Jokingly I called it "*and then we are hitting towards each other for half an hour*" and then full match play. With nothing in between. No hourglass model. No modules A1, A2 or B and gradually opening up to full match play. Especially with the group who needed it most.

- I attended a workshop called Tenniskids[12]. The teacher Mike Barrell expressed a lot of the basic training towards working with children.

"Do not let a kid try to jump 7 meters at once. But let him try to jump 7 meters by starting at zero and adding 20 centimetres each time".

"Tennis is often listed as a "sending and receiving" sport. In fact I would change that to "tennis is a receiving and sending sport!" Only the serve starts with the sending process. The remaining shots all start with the reception process. Reception is the core skill of our game and without it you just can't play!" [13]

A crucial remark he made, which I couldn't relate to the model I learned in my education, was the fact that besides the obvious sending skills he emphasized to train the receiving skills as well. It gave me the first idea to think about a pure Actual Tennis Action. Without any involvement of the Tactical Tennis Action. In the old (tactical) Tennis Action of my education the perception of the incoming ball had to provide service to the outgoing ball. In Tenniskids it was approached in an equal way. It was as important as sending. It was an eye-opener to me.

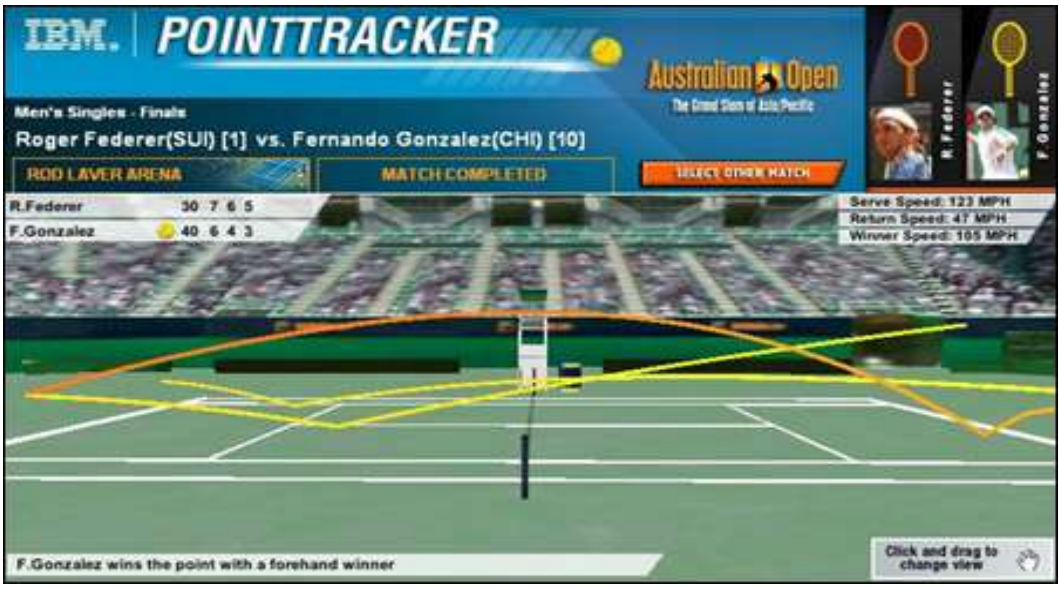

Image: IBM's Pointtracker

[12] Tenniskids is the official tennis program for children in The Netherlands. It has the same principles as TAUT, Play & Stay etc..
[13] Barrell, M.; Incoming!: Reception skills; ITF Coaching & Sport Science Review Issue 51, (2010)

- Many years before my education IBM launched Pointtracker[14]. A computer program with information about all the matches played during grand slams. One part occupied the reproduction of all the rallies played in one match with yellow and orange ball trajectories. Animations like in the DemoClip belonging to this book. Without actually seeing a player or a racket. It fascinated me. I didn't realize then that it would play such an important role in the years to come. If I had known that I would have saved many matches to my computer. IBM stopped the project after a few years. It took a lot of effort to get images from ball trajectories. The finding of the DemoClip was pure luck. There are hardly any pictures of ball trajectories. We don't communicate in such a way.

- A tennis buddy introduced me to Felix Kaplan[15]. His mantra: "Never hit a ball over the net!". In retrospect a very important and true principle. I hope that you will never raise the net again after reading my book. The premise of a ball trajectory is that it goes over the net and in the court. The usage of raised nets must be punished in the future.

- I began to think about our national (Dutch) dilemma. The penalty in (men's) soccer. What is the precise task in a penalty kick? I was also confronted by the free throw in basketball. The given answers were not satisfying me. I wanted to solve it.

- Three weeks before my final tennis exams I started visualizing all the ball trajectories which could be part of my exams. I visualized it in the yellow lines you can also see in animations during matches on the television. I made drawings of all the possibilities in a given game situation. I visualized the incoming ball trajectory and from different contact points the outgoing ball trajectory.

- I analysed ball trajectory shapes used by elite players. To look for ways to help my students.

- Manook Zorab was a fellow student. Manook has been the hitting partner of Brenda Schultz-McCarthy. Brenda was known as a woman with an amazing serve. Manook could serve even a little faster than Brenda. Impressive to witness that closely. At that time I hardly knew anything about the professional service. Though I practised my serve a lot. However the difference was too big (my service hardly reached the wall at that time). I knew for sure that it was not only talent. From that moment I knew there had to be systems in the body. Systems already known to the bodies of Manook and Brenda and not to my body. I was determined to discover everything about it.

- The perception that the score is an abstraction from the game. It says nothing about the quality of strokes. A point is just the consequence of the place of the ball.

In this book all these lose thoughts came together. At a certain point it felt like a totally convincing evidence. As a scientist you dream about it. That everything gets into its right place. I am anxious to take you there too.

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[14] https://en.wikipedia.org/wiki/PointTracker#PointTracker
https://www-03.ibm.com/press/us/en/pressrelease/7862.wss
http://ninarota.com/tennis/us-open-2005-ibm-point-tracker-more-than-you-ever-wanted-to-know/
[15] http://kaplanetics.com/?page_id=2

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In general I would like to thank all the people who came up with ideas to do something in a certain way or to not do things in a certain way. In the working field we need to respect all the people who are willing to do research and make that available to the public. If you want to brainstorm you only can flourish if you dare to shout unstructured things once in a while. Development will only be possible if other people can bring new thoughts to mind. The cancer research in the early years can now be seen as very simple. Nowadays the research is much more refined. And it will continue. One day cancer will be cured. Than they will have a little smile of empathy towards these first years. Nonetheless the first phase of research is most of the time the toughest one. To formulate the first research question takes a lot of effort.
Research is characterised as a process of increasing insights. What used to be good can in a minute be fully rejected if a better answer occurs. A cancer researcher though will think it's great if his lifelong work will be rejected if he knows that a colleague was able to cure cancer based upon the findings of his research. In science that is the way. I hope you judge this book in the same way. One person will cure cancer one day. But only as a result of the process of increasing insights from the effort of innumerable hours of many people.

I want to thank Anatoly Antipin for all the pictures with racket animations and ball trajectory animations.
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Introduction

The Game Idea is the central theme in a game. The Game Idea is traditionally appointed from the perspective of the spectator. The *old* Game Based Approach added a new perspective. The perspective from the player at the court.

> *The old Game Based Approach appoints the actions from how the player plays the game. As a counterpart of the Technique Approach they called it the Game Based Approach. The emphasis was placed on the game. In retrospect that appears to be wrong. My book is an explanation of the* Game Idea*. The real approach based on the* Game Idea*. The old Game Based Approach had to put the emphasis on* player *and* plays *and not on* game*. It should have been called the Player Based Approach*[16]*.*

The change of perspective is an important mind step. Every match you watch from the stands looks totally different once you enter the court yourself. The perspective from the stands is much easier. The education programs from the KNLTB and the ITF support this mind step and now help players in that way. The game of tennis requires different ball trajectories especially in different game situations. In one game situation you could defend the idea of ball trajectories being equal in form. Although there never will be a ball trajectory exactly the same. Either incoming or outgoing. The variation possibilities in ball trajectories are endless. Every possibility requires an adaptation from the player. That is why tennis can be considered an open skill sport. So before a player executes a shot he must add two important phases. First he has to perceive (P) in which game situation the shot is required and second upon that information he has to make a decision D). Then you execute (E) the shot and in the fourth phase you give feedback (F) on your shot. In short this is the core of the Game Based education programs.

Tennis Action: Perception → Decision → Execution → Feedback

[16] Chapter 9

This process we call the tennis action. The tennis action of the *old* Game Based Approach is a very good step in the right direction. In this book I will keep all the principles and even add a few things to the *old* tennis action. Because of the decision making I will call this tennis action the Tactical Tennis Action because another tennis action will be added. Till now it has not been discovered. I will call the new tennis action the Actual Tennis Action.

I want to take you to the DemoClip[17]. First look at it from the perspective of a spectator from the stands. At first the clip shows a rally between Nadal and Federer. We can see the characteristic game-play. Suddenly after a few strokes the screen turns black and the only things remaining are the court and the ball trajectories. You can see the creation of a chain of ball trajectories. The end of one ball trajectory is the beginning of the next ball trajectory. The chain stops when one player, in this case Roger Federer, cannot continue to add another ball trajectory to the chain.

The ball creates the game

Then I want to ask you to join one of the players at the tennis court and to start the DemoClip once more. First you see one of the players around you but soon you only see ball trajectories going back and forth. Do you see the connecting ball trajectories? Do you see the chain? Now you see the Game Idea in its purest form. Not from the perspective of the spectator, not from the perspective of the player but from the perspective of the ball. The Game Idea from the perspective of the ball is to form chains of ball trajectories and to prevent the opponent doing so.
We do say: "the game is played". That indicates that the game is a separate phenomenon. Nadal and Federer play the game. They play the game with their strokes, their bodies, their appearances etc.. That has always distracted us from seeing the pure game. At the end of the DemoClip you are not distracted anymore. The game has become an abstraction and can be witnessed without interferences.

Please stay a little while more at the court. Now pause the DemoClip at the end and look at one ball trajectory. If they had played with a rugby ball little could be said about the ball trajectory after the bounce. But tennis is played with a smooth round ball. One can very well predict the ball trajectory after the bounce. But not only after the bounce. The end of each ball trajectory can very well be traced back to the beginning of that ball trajectory. And from only the beginning you can make a precise prediction about the global outcome at the end of that ball trajectory. The only source of every complete ball trajectory is situated in the beginning of a ball trajectory. The only part a player can influence is the first initial little piece of the ball trajectory. It is not like in curling that you can influence the *ball* trajectory along the way. I call that the Initial Phase (IP)[18] of a ball trajectory. A player needs to put all the requirements for the whole ball trajectory in the Initial Phase. So the Initial Phase is also responsible for the shape of a ball trajectory after the bounce.
I will prove that elite players form perceptual perceptions out of the Initial Phase for both incoming and outgoing ball trajectories because they need information about the global latent outcome of the ball trajectory to help them with the actual game play. Global because it can't be precise and is not necessary to be precise at that moment. The global visualization of the latent part of the ball trajectory however is essential for playing the game. She gives compelling direction to the possible continuation. So don't watch the ball but watch the ball trajectory and try to make global conclusions about the latent parts as precise as possible.

The Game Idea leads to two tennis actions. The Actual Tennis Action is solely occupied with the prolonging of the chain. It has the main task to connect one specific incoming ball trajectory to one specific outgoing ball trajectory. The Tactical Tennis Action is solely occupied with trying to prevent this

[17] https://www.youtube.com/watch?v=JuD4cLlt5ik
[18] Chapter 1.4

prolonging process by the opponent. This is the whole description of the Game Idea from the perspective of the ball. There is nothing more. I had to find a name for the combined tennis actions. The combination of the Actual Tennis Action and the Tactical Tennis Action is called the Game Action.

By appointing the Game Action I was able to draw a few very important conclusions. A moving ball is inseparable from its trajectory. Its ball trajectory. The ball is leading and determines with its place in the ball trajectory the spatio-temporal actions which the player actually has to fulfil. But the ball trajectory is also leading. The shape of the ball trajectory will tell where the ball will be in the near future. A sound visualization of the shape of the ball trajectory out of the Initial Phase forces a ball to follow that visualization. That is a new and a little bit odd perspective. This book will clarify this completely. It has to do with the multiple possibilities of vision and perception. In retrospect we can conclude that the position of the perception (P) in the *old* tennis action was far too limited. I will prove that the perception is controlling or better predominating the whole process.

The fact that ball trajectories are connected in chains means that if I hit a ball to the backhand side of my opponent he will go there to hit the ball. I assume you made the same prediction but not reached this conclusion out of the Game Idea. The opponent has to go there for lengthening the chain. That is a different angle of viewing the situation. From there you can come up with exercises to visualize incoming ball trajectories even before you have struck the outgoing ball^{-1} (OGB^{-1})[19]. For the Tactical Tennis Action the biggest reduction of possible ball trajectories takes place during this phase. By consequently reasoning in this way out of the connection of the ball to its ball trajectory gives a lot of new insights. This book will uncover and describe them all.

The full explanation of the Game Idea is the ultimate premise in tennis. It is the premise of all premises. All methods, scientific research etc. have to give account to it. It is strange that it was never appointed before. Maybe there was an assumption that everything about the game was clear. Maybe as a newcomer I was the right person to appoint it in a different way. The game from the perspective of the ball , the scoring system, was never examined to its real basics. It hid the fundamental explanation of the game.

The full explanation of the Game Idea will have a lot of consequences. Here I will just briefly mention a few of these consequences. The book will fully cover the details.

- First of all the Game Action will shine a very different light on a lot of scientific research and tennis methods. A lot of it must be rejected as actual wrong. A lot of it must be reconsidered. The Game Action will give a compelling direction to supplementary studies. New research will have to consider the Game Action as a basis. The Game Action will prevent further useless research.

- The same applies to tennis methods. Especially the ones about the mental side of tennis. It is my claim that they mainly exist because coaches were unable to appoint the Game Action. These methods will be reduced to the minimal role they actually have. In the Game Action there will maintain to be mental processes. But in the Game Action they are much more limited and point their arrows much more to actual gameplay. Percentages of shots must be crossed against other percentages. What is my percentage of a particular shot in a game situation? Would it be higher if I make this choice or that choice? Which will be the options for my opponent then? What strong/weak points does my opponent possess? Is it better now to produce two high risk services? Or not? That is why I will make a plea for

[19] Chapter 1.2c

decision models which will support players in making these choices. Besides that all vision and perception processes are mental as well. But these mental processes can be approached much more specific.
By the way we don't have to ban all mental processes. People face certain problems while growing up. For example the transitioning from teenager to a young professional player can be mentally tough. Mental methods can attribute a lot in these kind of circumstances. But from now on it is not allowed anymore to connect them to the Game Idea of tennis in anyway.

- Every teacher must find his own way in the teaching process. Appointing the Game Idea in such a complete way gives a lot of guidance to that process. The Game Idea supplies a huge and steady basis which has no need to be changed every time a new method occurs. The teacher will no longer feel gaps. He will be able to compare the gameplay of his players with a compact idea that tells you exactly what to do. It leaves no room for different interpretations. It will show the teacher that teaching tennis is no longer a form of art but a form of craft. It requires hard and artisanal labour. Methods in tennis will become more homogeneous.
It also shows a teacher that he no longer can hide. The change of perspective from the spectator to the player in the *old* Game Based Approach already showed teachers that lessons needed to be *learner-centred.* No longer the student had to carefully watch the teacher but the teacher had to carefully observe the student and try to improve his gameplay. The teacher lost his central position which he had for decades when the *old* Game Based Approach was introduced. The Game Action will even more shift the responsibilities towards the coach.

- In common daily practice the *old* Game Based Approach wasn't really accepted. Maybe that had to do with coaches feeling gaps. Now, because of the Game Action fully explains the Game Idea, coaches can no longer avoid it. A description of the truth must be accepted and implemented. From now on teachers must be able to control and practise the Game Action.

- The mantra "Watch the ball!" will for always disappear. It will be replaced by "Watch the ball trajectory!". Another mantra "Go to the ball!" will mainly be replaced by " Let the ball come to you!". That is to say that even though a player sometimes actively has to move to an intersection point of ball curves he *always* has to give the ball the opportunity to come to the racket.

- It will produce *flow* and *playing in the zone.* If a player exactly executes the same actions as the Game Action prescribes him to do than the player will only execute actions and have thoughts which really are needed to play the game. Because the Game Action keeps the player occupied with looking for information he has no chance to get distracted. The ongoing tasks in the Game Action prevent that to happen. This is a big contrast with the task of only watching a *dead* abstract ball and don't look for information. A ball, besides from its brand, doesn't give any information. The trajectory of the ball does.

- It will deliver champions. The acceptation of the ultimate description in tennis will produce the most optimal methods. There always will be players like Serena Williams. But the Serena who is Game Action trained will always be superior to the Serena without the Game Action.

The ITF is now promoting the Game Based Approach. Although it has never been scientifically proven that elite players actually use it. The idea behind it and empirical experience demonstrates that it is the most logical way. With this book I follow the same road. Although I will bring a lot of evidence to the table that elite players see their matches in ball trajectories. Besides that the DemoClip is prove and also the description of the Actual Tennis Action. On top of that I will show that the model of the (new) full Game Based Approach is the model for every motoric movement action you make. Every movement in daily life, other sports , arts etc..

But in the end the only prove will come from scientific research. If the outcome of that research would show that no player is using what I describe than my theory is still the best assumption of what should be done.

As I mentioned before there is no place for technique in the Game Action. They belong to two different worlds. The Game Action explains the game and all of the compelling actions out of the perspective of the ball. It is played with technique. The technique describes all the processes out of the perspective of the player. So the technique is extracted from the *old* tennis action. In the Motoric Movement Action of tennis the technique is glued to the outside of the Game Action. That is why a substantive discussion of technique is outside the scope of this book. This book handles the complete description of *the game* of tennis.
However in my research I spent as much time on technique as I did on the insights of this book. Like I explain the Game Based Approach as a complex system I succeeded to appoint models of professional strokes in the same way. I discovered multiple models in every stroke[20]. I will not discuss them substantively but I will appoint their relationship with the Game Action. Elite players found surprising applications outside the current thinking approach of fast, faster, fastest. Their findings can support future quests to create better technical models.

The book lying before you explains the game of tennis as a complex system model. Books however are very well suited for linear explanations but not for explaining complex systems. A complex system is complex because all the parts have all kinds of relations with other parts. I picked a logical way to describe the parts but keep in mind that we are talking about a complex system.

[20] Chapter 13

Chapter 1 - Definitions and Theories

1. The *old* Game Based Approach (GBA^O) versus the *new* Game Based Approach (GBA^N)
2. The ball trajectory
3. The shape of a ball trajectory and ball trajectory defining factors (BTDF)
4. The Initial Phase (IP) versus contact point (CP)
5. Tempo
6. Game intentions
7. Complex system versus linear system
8. The Tennis Action (TA)
9. Self-1 and Self-2
10. The hourglass model

In this chapter I will only appoint those definitions and theories which are relevant to this book. Most of them find their roots in a Game Based Approach education program. This chapter is not an alternative to become a Game Based Approach teacher. The information in here is much too limited.

1. The *old* Game Based Approach (GBA^O) versus the *new* Game Based Approach (GBA^N)

In retrospect I can see that "Watch The Ball Trajectory!" is the real and full Game Based Approach. This book solely origins from the explanation of the game. The game is outlined as a complex system. Its main goal is to describe the game and not to help players. Although methods can benefit from it one should understand the proper order.
However there is a problem. There is already a Game Based Approach. As a reaction to the Technique Approach[21] a movement arose emphasising that tennis is an open skill sport. They explained that there is not one perfect technique. A player must adapt to every game situation with a different stroke and a corresponding technique. Strokes must be *functional* instead of *ideal*. The movement against the Technique Approach called themselves the Game Based Approach. They wanted to help the player to play the game. They emphasized the word *game* and that appeared to be wrong. They indeed helped the player but the game wasn't explained in a better way. In retrospect they had to put the emphasis on *player* and *to play*. They should have called it the Player Based Approach.

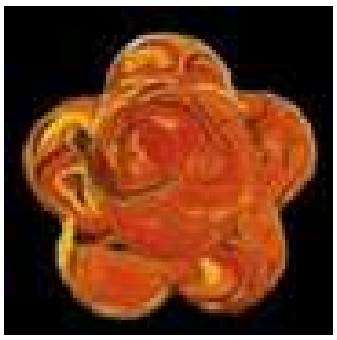
However the term Game Based Approach is established in the whole world. It is not that bad as long as people will understand the differences.. The discussion around this subject is purely academical. In my book I will use the two terms regularly and it is against my principles to find a different term for what something really is. So I chose to call the *old* Game Based Approach the GBA^O and the *new* Game Based Approach the GBA^N.

2. The ball trajectory

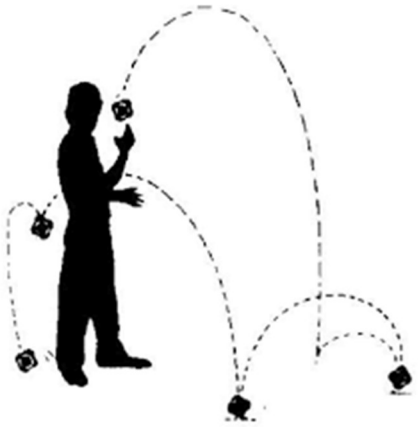
a. The relation between the ball and the ball trajectory

[21] Chapter 9

Every moving ball leaves a trail. A *Z-ball* will show a strange and irregular pattern. But this ball also created a ball trajectory. If one could throw a Z-ball at the exact same place the ball trajectory would show big differences with the former one. No pattern will occur in the innumerous possibilities this ball hosts.



Z-ball



Z-ball bounce behaviour

Moving tennis balls however do show regular patterns. A tennis ball is a smooth round ball. A tennis ball has a set relationship for every time (t) with a certain place (P). For t(0) →P(0); for t(1) →P(1); for t(2) →P(2) etc.. Ball trajectories are projections of all the points P the ball will encounter in time. They show a recurring steady pattern. A reproduction of a ball trajectory will globally show the same characteristics. If that wasn't the case tennis couldn't be played. When a ball trajectory is actually produced the ball is in front of the ball trajectory. The ball has relations with all times $t \geq 0$ and all places P. But a ball has also relations for every time $t < 0$. So for t(-1) →P(-1); for t(-2) →P(-2) etc.. After the Initial Phase a ball trajectory cannot be adjusted like in curling.

So it is very well possible to make statements about the shape of a ball trajectory even if one only knows the beginning of a ball trajectory. One can precisely predict the global shape of the ball trajectory after the bounce. And vice versa from the end of a ball trajectory one can precisely predict the global shape of the beginning of that ball trajectory.

So perception mechanisms will be able to precisely predict the global shape of the latent end of a ball trajectory when a ball trajectory is just produced. That is the premise underlying this book. The ball is going to make its ball trajectory but also casts its shadow forward. The Initial Phase is determining which shape the ball must follow. There is continuous mutual relationship. The ball shapes the ball trajectory but has to follow the shape as well.

b. Valid ball trajectories

When I mention a ball trajectory in this book I mean a valid ball trajectory. A valid ball trajectory is the requirement for continuing the chain. For the Game Action the only premise of a valid ball trajectory is that it either hits the opponent's court or hits the opponent's racket. A ball trajectory will never ever have to pass the net. The premise of the ball trajectory already covered that aspect.

c. Chain, cycle, pattern and the outgoing ball trajectory^{-1} (OBT^{-1}).

A player has to prevent the opponent from adding a new ball trajectory to the chain. If that mission failed the player must add a new ball trajectory to the chain. So the end of one ball trajectory is the beginning of the next ball trajectory. In that way ball trajectories are visually attached to each other in chains.

Parts of the chain are defined as follows:

- Cycle: One cycle in a chain exists of two ball trajectories. In Game Based Approach education programs the tennis action starts with an incoming ball and ends with an outgoing ball. I keep it that way. Although I change ball to ball trajectory. So one cycle contains one incoming ball trajectory (IBT) followed by one outgoing ball trajectory (OBT).

- Pattern: A pattern contains a sequence of cycles with a progression of game intentions.

- OBT^{-1}: In one cycle the IBT and the OBT are the central issues. The Tactical Tennis Action will add an important phase to the anticipation process. An important meaning will be attached to the one OBT which is played before the IBT. This ball trajectory is called the OBT^{-1}. The other outgoing ball trajectory is not called OBT^{0} but just OBT.

3. The shape of a ball trajectory and ball trajectory defining factors (BTDF)

a. Ball trajectory defining factors (BTDF)

The level at which any tennis player plays the game says globally which tennis skills he possesses. Within one level not all the skills needed are developed at the same height. It is about the sum of those skills. The sum of the skills always represent the level of a player. This sum of factors is different at any other level and globally develops in a set way.
For that reason we call these factors Level Defining Factors (LDF). They consist of factors like: how a player handles Ball speed, Consistency, Direction, Ball Reaching Footwork (BRF)/Court Defending Footwork (CDF), Rotation, Mental etc.. A coach needs to scout these LDF within a player. The Player Based Approach needs to gather information about the most relevant particular factor that withholds a player from the next level. That is one of the main goals in Game Based coaching.

The shape of a ball trajectory contains factors that look like the LDF. The shape of a ball trajectory is dependent on direction, ball speed and rotation. These are the objective quantifiable factors. Two more subjective factors are tempo and pressure. The LDF have certain set relationships with BTDF.

b. Shape of the ball trajectory versus BTDF

I would have loved to bring the shape of the ball trajectory under the BTDF. But that is not possible. The shape of the ball trajectory is much more than a part. The shape is influenced by the BTDF but also has a big dimension on its own. The shape of the ball trajectory is mainly caused by the angle of departure[22] of a ball trajectory. The elevation angle is the angle the racket face makes towards the ball during the Initial Phase.
A ball trajectory is only created when a ball is moving. So there is always ball speed and direction. Noticeable rotation is not always there. Rotation adds most of the shape of a ball trajectory after the bounce.

[22] Chapter 10.2

So all these factors contribute to the shaping process of a ball trajectory. It is not the question if they contribute but rather how do they contribute. Are some factors dominant over others[23]? That is what a player needs to learn. He has to know the set relations between the shape and the BTDF. I will give a few examples.

First a not to tennis related example. Let's look at darts. The player is positioned at 2.37 meters from the board. It is not a distance from where you have to throw a dart with speed. If the player would have been positioned at 25 meters from the board *dart* speed would become the dominant factor. Rotation and direction are not relevant. The most important factor in darts is the execution of the shape of the dart trajectory. The shape is dominant over the dart trajectory defining factors.

We return to tennis.

Game situation 1:
Single, Baseline, Forehand-cross rally; A player perceives that a ball is too short. He moves forward and hits the ball down the line and approaches the net.

In this game situation the opponent has four reference ball trajectory options. From the forehand corner he has to move to the backhand corner and has the choice to: 1. make the passing shot long line 2. make the passing shot short cross-court 3. hit a lob cross-court and 4. hit the ball towards the opponent.

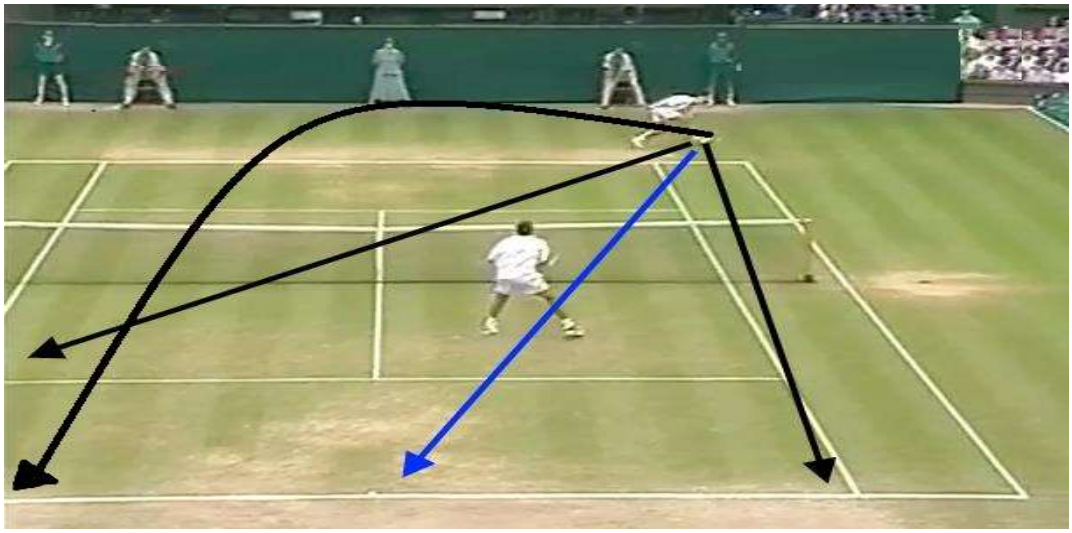


Image: game situation 1

The possibilities 1, 2 and 3 mainly need shape of the ball trajectory. Just like in darts. The BTDF have to follow the shape in a *natural* way. Option 4 (blue line) is different. In option 4 direction (to the hitting shoulder of the opponent) is more relevant than the shape and ball speed has to dominate for this option to succeed.

Sometimes students ask me, in case of the black lines, if they have to hit slowly. Then I explain that it is not about slow or fast but that they have to make the shape of the ball trajectory with a natural speed. The ball speed will remain high though. I explain to them that there is maximal power and there is good power. That good power is attached to a much higher consistency rate. And more important

[23] Like in the technique models. Chapter 13.3

you don't need it. If you gained an advantage in tempo during a rally you only have to exploit that in a dosed way.

Game situation 2:
Single, Baseline, neutral rally.

If a player, with less quality in LDF and BTDF, will maintain a good shape of the ball trajectory he will be able to neutralize the rally for a long time. The opponent will put pressure on him but will not gain an advantage in tempo. So mainly this player will have to *follow* the controlling opponent but he can stay in the rally. You can see that in matches on a daily basis (Andy Murray). Only if the BTDF fail to reach the lower limits than the opponent will gain an advantage in tempo.
So in this game situation the shape of the ball trajectory is the main factor to keep the opponent behind the baseline. The shape is dominant over the BTDF.

- **Direction** is an autonomous factor. It is mainly concerned with tactics. How will the end of a directed ball trajectory compare itself in distance to the opponent? Will the ball come to the opponent or will the opponent have to move towards the ball? [24]
Direction is an important part of consistency percentages. A little difference in ball trajectories down the line means in or out. A cross-court ball trajectory will not suffer from that.

- **Ball speed**. Above certain velocities ball speed is a very dominating factor. The transitioning of the Motoric Movement Action *catching a ball* to the Motoric Movement Action *throwing a ball* needs a saccade (eye-jump) from the eyes.[25] With velocities above 220 km/h at fast surfaces there will be real physical problems to execute this.

If the ball speed decreases the dominance will disappear soon. The shape of the ball trajectory than takes the leading role again. Though ball speed will always have an important role. At every level you want the opponent to move backwards as much as possible. Both the shape of the ball trajectory and the ball speed determine whether an opponent experiences pressure.

Image: Game situation 3. 1st *slice* service is played outwards. Return with a low ball trajectory with a lot of ball speed back to the opponent. Followed by an easy winner in the open court.

[24] Chapter 10.10
[25] Chapter 5.2

Ball speed is in the era of power tennis a very important factor. However I think it is overrated in nowadays coaching. The current coaching's mantra is still fast, faster, fastest. One should also emphasize dosed ball speed during gameplay. You can see a lot of players put pressure on themselves by choosing a lower ball trajectory with maximal ball speed in a game situation where they experience pressure. By choosing a different shape of the ball trajectory and/or ball speed they might be able to fulfill the task of Court Defending Footwork (CDF). Now the follow-up is an easy scoring ball of the opponent.

Game situation 3:
Single, Return on Service, to a slice service from deuce court hit outwards with maximal ball speed.

The player who returns has to stretch towards the ball and that will bring him outside of the court. A returner who chooses to return with a lower round ball trajectory and maximal ball speed out of the 1st tempo[26] of the ball trajectory inflicts maximum pressure on himself. He will never have the time to cover his court. The player who served can make an easy winner in the open court.
This happens a lot. Of course this game situation is a tricky one. The player faces a lot of pressure. However the solution is definitely not situated in trying to teach this player to return with even more ball speed (fastest). The faster he hits the ball the sooner the ball will return into his court. All the possible ball trajectories he can make will return towards the opponent. In general, ball trajectories with maximum ball speed have a tendency to move towards a player and especially in this game situation. You have to try to find solutions in diminishing ball speed and other ball trajectories. You have to try to gain time and/or try to give low intersection points to the opponent to continue the chain. With lesser ball speeds opponents have to generate the power themselves and they often will have to approach the ball for a good hitting position.

Image: spin rates belonging to Rafael Nadal[27].

- **Rotation** is an important BTDF. Especially for the shape of the ball trajectory after the bounce. Although it will hardly ever be dominant over the shape. If a player hits a slice ball trajectory his goal is to give the opponent a low intersection point at the end of the outgoing ball trajectory and no ball speed to work with.

[26] Chapter 10.3
[27] https://www.youtube.com/watch?v=kQEd5m_tof4

4. The Initial Phase (IP) versus Contact Point (CP)

In a chain of successive ball trajectories two curves are linked in the intersection point. In tennis we call this point the Contact Point. It is the exact point where the racket encounters the ball. However a ball trajectory is not produced in this point for 100%. It is a very important point but I want to appoint it a little wider. A player has a small but a certain time unit to make the ball trajectory.

This is called the Initial Phase. It covers the period of time from just before till just after the touching of the ball. The last moment of the main phase of the racket swing the racket head approaches the ball with an angle of departure. Just after the hit the racket head has to go *through* the ball.

The main goal of the Initial Phase is to actually create the perceptual perception of the latent outgoing ball trajectory (OBT). During the Initial Phase the ball must be launched into the beginning of that perception. The angle of departure is very important. It says a lot about the first shape of a ball trajectory.

Image: *The Initial Phase* – Maria Sharapova hits a forehand. There are 22 numbered points mainly situated in the main phase of the racket swing. The Contact Point is at point 19. The Initial Phase is situated between points 18 and 20.

A ball trajectory is being created during the Initial Phase. A player needs to insert all the conditions in that phase to achieve the desired shape at the end of the ball trajectory. It is not like in curling. You are not allowed to *sweep* once you completed the Initial Phase. Because a player is obliged to use the Initial Phase to shape the whole ball trajectory it is possible to globally see the whole ball trajectory just after that phase. A player can camouflage a lot but during the Initial Phase every intention about the ball trajectory is revealed.

"Thus, the hitting sequence is a complex skill that requires the integration of visual information mainly gained in the first part of the ball trajectory.[28]*"*

One can distinguish two Initial Phases. The Initial Phase of the stroke and the Initial Phase of the ball trajectory. The latter only relates to the beginning of the ball trajectory. It proceeds a little longer than the Initial Phase of the stroke. There is a set relationship between the two. It is only important for coaches to know the difference. When the Initial Phase is mentioned in this book both phases are meant unless specifically stated otherwise.

[28] Gaze Control During the hitting phase in Tennis: a Preliminary Study – D. Lafont ; p. 94

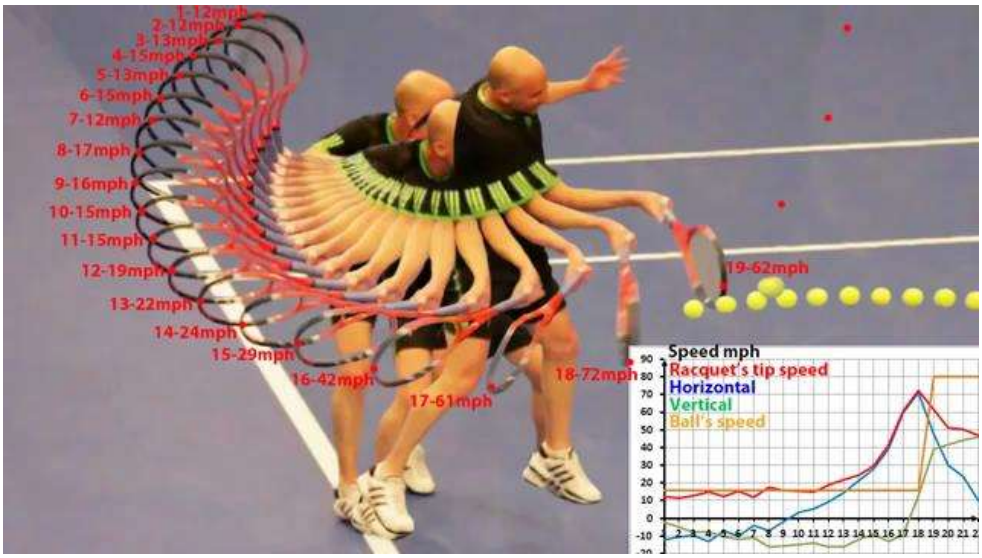


Image: *The Initial Phase* – Andre Agassi hits a forehand. There are 19 numbered points situated in the main phase of the racket swing. The Initial Phase is situated between points 18 and 19.

5. Tempo

The word tempo[29] is being used for two different phenomena.

a. The first use of the word tempo is for the exact intersection point where a player determines to create an outgoing ball trajectory at the end of an incoming ball trajectory. For a groundstroke the 1st tempo is located after the bounce and before the highest point. So it is located in the rising part of the ball trajectory after the bounce. The 2nd tempo is situated in the descending part of the ball trajectory after the highest point. This tempo can be determined objectively.

b. The second use of the word tempo is as a ball trajectory defining factor (BTDF). In this case it is subject to the whole ball trajectory and is an indicator for who dominates a rally. The player who really dictates has won the tempo in that rally. Players with big serves immediately gain the tempo after the service. This explanation of tempo has a more subjective connotation.

6. Game intentions

Every game consists of game intentions. Game intentions in tennis are related to the second part of the Game Idea. To prevent the opponent to continue the chain. They are part of the Tactical Tennis Action.
The explicit appointing of game intentions is not relevant for a player. It is an important standard among coaches. Does a player use game intentions? And in what way does he use them? It is important that a player uses game intentions and that he can use them in a progressive way. Game intentions must develop from 1. Preventing to Score (PtS) to 2. Building (B) to 3. Scoring (S). In that way

[29] Chapter 10.3

patterns, in chains, of ball trajectories can be seen as connected game intentions. Game intentions have to be connected to the BTDF *tempo* and *pressure*.

There are five classical groups of game intentions. The Game Action rewrites them in the following way:

a. Scoring (S)
A player scores if an opponent cannot continue the chain of (valid) ball trajectories. A player who scores makes an outgoing ball trajectory from which an opponent cannot use the end for an intersection point or from which an opponent cannot make a valid outgoing ball trajectory.

b. Building (B)
A player will be able to build in a rally if he dominates in pressure or tempo. This player has the initiative.

c. Preventing to Score (PtS)
Preventing to Score is the opposite of Building. A player experiences pressure from the opponent. The opponent has the initiative. The player must do his utmost to prevent the opponent from progressing in building from the viewpoint that tennis is a game of mistakes and that attacking is more difficult than defending. Besides that sudden changes are possible in tennis.

d. Neutralising (N)
The primal definition of neutralising is to make ball trajectories without game intentions. You have to teach beginners to play with game intentions. At a higher level this part belongs more to Preventing to Score. A player must be able to answer a pressuring incoming ball trajectory with a ball trajectory that takes away most of the pressure. That means that the opponent will be able to maintain pressure but doesn't gain a profit in tempo.

e. Evoking (E)
For the Game Action evoking falls within building (B). The Game Idea and the Tactical Tennis Action show that a player has to learn to play the game with perceptual images of the outcome of ball trajectories after the bounce. The outcome related to the position of the opponent. An example of evoking is playing a dropshot. A dropshot can only be executed successfully out of the 1st tempo of a ball trajectory after the bounce. The structural mistake in creating a dropshot is that a player knows when to hit it but not to hit in the 1st tempo phase of a ball trajectory. Most players hit it out of the 2nd tempo when the ball is descending. Than the idea has been wired across the net for a long time and the opponent is already on his way to reach it easily.

7. Complex system versus linear system

The implementation of complex dynamic systems[30] in sport is a relative new development. Tennis meets all the requirements of a complex system. Tennis is open, independent, dynamic, non-linear and multi-causal. However most of the methods approach tennis in a linear way. If we want to discover the essences of tennis we need to develop a systemic thinking approach. An approach which has to consider all the relevant variables and put them together in one complete model. Explanations of the world as complex systems is also known as the "science of complexity".

[30] https://en.wikipedia.org/wiki/Systems_theory

"*This approach consists of perceiving complexity and trying to find an order and to simplify it as much as possible.*[31]"

"(...)current thinking has shifted from linear to nonlinear and from uni-dimensional to multi-dimensional models for research. Sport psychology scientists now believe that the interactional approach of individual and situational factors will take the field closer to the goal of understanding, explaining, and predicting behaviour (...). However, this focus on multiple variables, complex systems, and nonlinear relationships is in direct opposition to the current Newtonian approach of trying to understand the world by examining individual components (...). Rather, a macroscopic examination of complex, nonlinear systems is needed to aid our understanding. Therefore, the purpose of this paper is to provide a brief overview of such an approach, namely chaos theory. We acknowledge that in our attempt to explain and apply chaos theory to sport behaviour, there is the potential for over simplification of a complex mathematical theory.[32]*"*

"We are convinced that eventually also the other universal properties of complex adaptive systems will prove to be helpful not only in understanding but also in coaching the multitude of current and most likely future types of sports and games both on physical as well as on virtual playing fields and arenas.[33]*"*

"Tennis coaching and training has traditionally been dominated by a mechanical concept of the player and the game (i.e. the consideration of the tennis player as a sum of different parts: mind and body; and the notion of the game as composed of different areas: technique, tactics, conditioning, psychology, etc.).1 This ideological stream, known as "mechanicism", imposed a fragmented and mechanical approach to the perception of the environment, and was originated during the industrial revolution in the 19th Century by emphasising the notion of progress and technological development.

This paradigm coupled with the traditional scientific method, which basically assumes that the understanding of the parts of a given system would provide the understanding of the whole, and is also known as "reductionism". As such, this linear reductionist approach requires that the researcher isolates a variable or variables within the system under study for data collection at a specific time.

Sport sciences applied to tennis have followed the use of a reductionist philosophy (either deductive or inductive) which has been the predominant paradigm throughout the fields of science for centuries. This approach is a microscopic and not a macroscopic one since it investigates isolated parts of a system. It has also been called a linear (as opposed to non-linear), isolated (as opposed to integrated) and a reductionist (as opposed to holistic) approach. Although the deductive or inductive approaches have contributed to our understanding of the game, the results using these classical frameworks and methodologies have shown that it is difficult to understand complex sport behaviour."
"The concept of integrated training for tennis states that the traditional distinction between technique, tactics, conditioning, and mentality is more artificial than real.[34]*"*

This book explains tennis as a complex system. The Game Action will not allow other explanations. All linear explanations of tennis as a whole must be rejected from now on. The full Game Based Approach explains tennis in one complex system model. This book will also appoint all the subsystems. It is important to know if subsystems can be engaged as complex or linear. The basic assumption in this book is the applicability for the player. What can be approached simple must stay simple. Opening a door with a key can be described as a complex system. There are a lot of physical processes going on

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[31] https://en.wikipedia.org/wiki/Complexity
[32] Chaos Theory: A New Science for Sport Behaviour?, M. Mack; http://www.athleticinsight.com/Vol2Iss2/ChaosPDF.pdf
[33] Complex Systems As Fundamental Theory Of Sports Coaching; G. Mayer-Kress; http://arxiv.org/html/nlin/0111009v1
[34] Miguel Crespo; J Med Sci Tennis 2009; 14(2):20-25 "Tennis Coaching in the Era of Dynamic Systems"

which can be characterised as complex. However from the perspective of the person who opens the door it is just a linear job. Key out of your pocket, in the lock and turn. That's all. In that way I will too approach subsystems.

8. The Tennis Action (TA)

"In the next scheme the tennis action is explained: Perception → Decision → Execution → Feedback. [35] *"*

The tennis action in here is explained as a linear model. The tennis action is the leading motive in the Game Based Approach education program of the Royal Dutch Tennis and Lawn tennis Union (KNLTB). It evolved from the *old* Game Based Approach which was the answer to the then leading Technique Approach. Once they realised tennis is an open skill sport two phases were added prior to the execution.
Because this book will add another tennis action this tennis action will be called the Tactical Tennis Action. Its concerns revolve around the tactical choices a player has to make. The other tennis action will be called the Actual Tennis Action. Together they will be called the Game Action[36]. The vision and perception processes cover the whole process in many ways. They perform a dominant and over-powering role. Because of this, the conclusion will be that the Game Action can only be appointed as a complex system.

9. Self-1 and Self-2

a. Explanation

The book *The Inner Game of Tennis* by Timothy Gallwey is a standard work in the world of tennis. I was forced to read it during my education. It appears on a regular basis on every tennis forum. Maybe it is the most well-known tennis book.

"A major breakthrough in my attempts to understand the art of relaxed concentration came when, while teaching, I again began to notice what was taking place before my eyes. Listen to the way players talk to themselves on the court: 'Come on, Tom, meet the ball in front of you.' . . . Who is telling whom what? Most players are talking to themselves on the court all the time. 'Get up for the ball.' 'Keep it to his backhand.' 'Keep your eyes on the ball.' 'Bend your knees.' . . . It's like hearing a tape recording of the last lesson playing inside their head . . . One day I asked myself, Who was talking to whom? Who was scolding and who being scolded. 'I'm talking to myself,' say most people. But just who is this 'I' and who the 'myself'? "Obviously, the 'I" and the 'myself' are separate entities or there would be no conversation, so one could say that within each player there are two 'selves.' One, the 'I,' seems to give instructions; the other, 'myself' seems to perform the action. Then 'I' returns with an evaluation of the action. For clarity let's call the 'teller' Self 1 and the 'doer' Self 2."

Self-1 is supposed to be the jamming station containing all the concepts how things are supposed to be. Including all our judgements and associations. Self-2 is appointed as the huge reservoir of potential we hold inside our bodies. If it threatens your potential it is Self-1. If it expresses your potential it is Self-2.

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[35] KNLTB curriculum A; p. 28
[36] Chapter 8

This appointing of Self-1 and Self-2 is the most well-known part of the book. I will maintain this usage in this book. It is known all over the world and it expresses something people recognise very well.

b. Flow and playing in the zone

The player with the self-talk mentioned above gives himself directions not within the task of Game Action. The Game Action exactly describes what belongs to the task and explicitly describes what doesn't belong to the task. Self-talk with instruction not belonging to that task will indeed harm playing the game. Self-talk based upon the tasks from the Game Action will never hinder a player. Au contraire it can help him in several ways. If a player will only execute the necessary actions according to the Game Action his body will experience and incorporate this as the truth. The body will experience this as *flow* and *playing in the zone*.

By the way "Watch The Ball Trajectory!" will prove that all proposed methods in Gallwey's book also reinforce Self-1. They all have to be rejected. His most famous method *to look at the seams of the ball* is one of the main issues in his book. This cue has kept people from improving for maybe more than a century.

If we return once more to the player with self-talk we can in retrospect conclude that this player gives himself the wrong instruction. The instruction he got in lessons from qualified teachers. He went there to improve his game. In the lesson the result was okay because the teacher fed him a perfect ball. A perfect ball with no variation whatsoever. The positive result wasn't due to an explanation of the real tasks in tennis. Now in the match the player is confronted with a large variety of and very different incoming ball trajectories. This nasty opponent refuses to feed this one nice ball trajectory he trained in his lessons. The player cannot apply the things he learned in his lessons because the game situations keep on changing. However the player thinks he is to blame himself and is now parroting the feedback he got from his teacher. In retrospect the Game Action will show that this player was never to be blamed. The ignorance of the teacher or the educator of the teacher is to be blamed for not appointing the real tasks in tennis.

The Game Action will prove that most theories and methods reinforced Self-1 for decades. They will all have to be rejected. In this way I will also prove that raised nets and targets *where players have to aim at or hit over* must be banned. The focus must be changed towards knowledge about and the creation of ball trajectories. Valid ball trajectories will automatically go over the net and touch a certain place in the court of the opponent.

10. The hourglass model

If a coach wants to optimally help a player he has to scout the player's gameplay first. One of the qualities of a good coach is that he can make a good assessment of the skills of a player compared to the general needs for his level. A good coach is able to appoint a global curriculum for this one player. If a player wants to raise his level a coach must be able to appoint the shortest way to the next level in a very player specific way. What are the essential skills withholding this player from playing just one level higher. That's far more difficult than to appoint what he needs to get to a pro level.

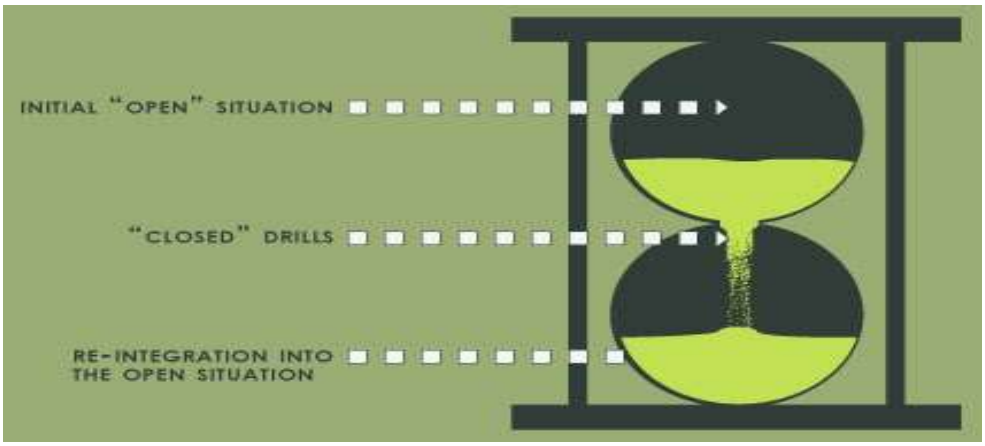

Image: The hourglass model

From this scouting report a coach will have to come to an agreement with the player to work on the crucial points. This agreement will lead to a working plan for the next lessons. The working plan will give priority to the biggest problem.
Once we are in the lesson the teacher will narrow down the game situation in which the problem occurs. He will keep on narrowing down the game situation till he really found the problem. This is the description of the upper half of the hourglass model. From the match situation you narrow down to a very closed situation.

"The procedure known in coaches jargon as open-closed-open (Pankhurst 1999) or global-analytic-global (GAG - Maier 1999) became very useful in enhancing both technical and tactical skills easier, faster and more attractive way. The use of the mediational learning technique in correcting players corresponds with this approach."[37]

In the closed situation the problem is addressed. Than the teacher will gradually open the game situation. In very particular steps he will bring back the closed situation to full match play.

[37] Crespo, M. & Unierzyski, P.; Review of modern teaching methods for tennis

Chapter 2 – The Problem Definition ~ *The Quiet Eye* versus *The Active Eye*

1. *The Quiet Eye* versus *The Active Eye*
2. Flow and playing in the zone

1. The Quiet Eye versus *The Active Eye*

Every action in which a person executes a task with a movement of the body we can define as a Motoric Movement Action (MMA). This covers almost all of the movements we make except for unconscious actions like for example the beating of the heart, the blinking of the eyes etc.. All tasks where a conscience will of a person is involved can be considered a Motoric Movement Action. You can think about turning on the light, to open a lock, to poor tea, to drive a car, cooking, eating, play games/sports etc..

Every Motoric Movement Action we execute has a cognitive basis. Even in a comfortable chair at home we can make a cognitive image about any Motoric Movement Action. If for example we want to post a letter we know what is the task. In our minds we can observe ourselves executing this task. We can imagine this task at *our own* mailbox but also as a general action at all mailboxes there may exist. Besides that we can make an abstraction of this task. You know that you have to deliver an object, that you have to keep that object parallel to an insert possibility, that once the object is close to that insert possibility you have to make a little throwing action, etc.. These abstractions also consider that the object must *fall down* into a collecting object. So the insert possibility must be at some height to make that possible.

If we are really going to post a letter at a *new* mailbox we first make a tactical plan with the cognitive basis as a reference. We construct a perceptual perception of a latent trajectory from the letter in our hand to the slit of the mailbox. The action trajectory. Than we are going to actually execute this latent perception. We bring the letter into the action trajectory which will guarantee a successful delivery and follow the tactical plan. With other words we throw the letter into the beginning of the *letter* trajectory which is already there and which the letter cannot escape. While actually executing this task many more perception processes will take part. They are processed in two streams. The ventral and the dorsal stream. The ventral stream is mainly concerned with the action trajectory. The letter is observed but the emphasis is laid on the trajectory. The dorsal stream is mainly concerned with the letter. The

action trajectory is observed but the emphasis is laid on the letter. During the actual action these streams audit each other in an ongoing mutual process. If the letter deviates from the perception of the action trajectory a new perceptual trajectory is created immediately. The letter will have to follow this new trajectory again and is audited again by the dorsal stream. This will continue till the letter reaches the slit of the mailbox.

Now most mailboxes are solidly attached to the ground and so most motoric post actions won't need a lot of corrections. But let's try to imagine that you are in another country and the mailbox is stable moving horizontally side to side over a length of 50 centimetres. Than you will witness this mutual process much better.
The cognitive basis has not changed. When you arrive at this mailbox you conduct a quick research and again you make a tactical plan based on the actual environment information. From your position you can reach the slit of the mailbox. The difference with the stationary mailbox is that the perception now constructed more perceptual perceptions of possible action trajectories. A global image of possible action trajectories. Because you can't make a precise latent action trajectory yet and at this moment there is no need for a precise action trajectory.
After you made a tactical plan you are really going to execute the actual *post* action. It would be nice if you would really join me in this action from this point. With the global perception in mind you bring the letter up into most of the global perceptions of possible trajectories. The main goal now is to get the letter closer to the slit. The two processing streams are more active now. The ventral stream shows changing action trajectories every following time unit which you try to follow for a bit as a global leading guide. The dorsal stream is correcting more actively.
Still you manage to get closer to the slit. The perceptual action trajectory is now actually completed for most of its part. There is just a little part of the latent action trajectory left. The more an action trajectory is actually completed the more the chance to deviations diminishes. It will diminish exponentially. In this last phase the actual post action can there for change the emphasis from bringing the letter closer to the slit to actually inserting the letter into the slit. Although all perception processes will maintain to do their jobs like mentioned before. You will have to keep feeding the latent perceptions of the action trajectory. The dorsal stream will audit the process from the actual position of the letter. They will keep processing till the task is fully completed.
In the mean time you brought the letter in your hand parallel to the slit. The insertion task, out of the cognitive basis and the ventral stream, is responsible for this. This will lead to posting this letter as well. Although you wonder if you ever will come back at such a mailbox

Of course this is an exaggeration. But this is what you normally do when you move your body, a part of your body or an object you control. In the actual action trajectories we make in everyday activities there are multiple little deviations. We don't experience them consciously. If you are not convinced than try the next game. If you really make straight lines you will have no problem whatsoever with the *nerve spiral*.

Image: *nerve spiral*

Because the explanation of the Motoric Movement Action is universal you can apply it as well to this situation. You have a cognitive image of the task at hand. If there were a *new* nerve spiral in front of you now, you would make a tactical plan based on cognitive knowledge and the one specific spiral in front of you. You can visualize all the specific curves of this spiral. The final goal of the tactical plan is to come up with only one whole action trajectory. It is necessary for leading the Motoric Movement Action.
When you are actually going to perform the task you will be caught in the two processing streams of the perception. That produces all the irregularities people experience while executing this task. If I perform this task the bell would ring at least ten times. I hate these things.
We don't possess one processing stream but two. The ventral stream mainly considers the trajectory for the completion of the task. The dorsal stream mainly considers *the ring* of the apparatus you are holding relative to the spiral. They work together in an ongoing mutual auditing process till the task is done completely. Because signals from both streams take a little time to be processed you will experience these little *hiccups*. This is very well known and produces – *ring* – the touching – *riing* – of the spiral – *riiiing* – and the ring.

"The dorsal stream and the ventral stream (see diagram 3 & 4)[38]

It takes about one-tenth of a second for information about the visual scene to reach the back of the brain or the occipital lobes. During the next tenth of a second, the visual information is analysed in two separate ways. Figure 2 shows the two pathways of the dorsal stream and the ventral stream. The dorsal stream runs from the occipital lobes to three locations, the back of the brain at the top (called the posterior parietal lobes), a vertical strip of brain in the centre (called the motor cortex) and the front of the brain (called the frontal cortex).
The ventral stream runs from the occipital lobes to the back of the brain at the bottom (called the temporal lobes).

The Dorsal Stream

The motor cortex is responsible for bringing about movement of the body. In an adult who has had a stroke and who cannot move the right side of the body, it is the left motor cortex or the pathways from the left motor cortex which have been damaged. The top of the motor cortex is responsible for moving the foot and the side of the motor cortex is responsible for moving the hand. The task of picking up the apple involves both the visual system and the motor cortex. First, the apple has to be recognised, it then has to be mapped along with everything else in 3-dimensional space by the posterior parietal cortex.. This information is passed to the frontal cortex which is responsible for making the executive choice of attending to and picking up the apple. The information about where it is then passed to the motor cortex responsible for moving the hand, which reaches out accurately in 3-dimensions using the coordinates given to it by the parietal cortex, in order to pick up the apple. At the same time, the hand is being shaped so that the fingers are separated far enough to encompass the apple. Once the hand has reached the right position, the fingers grasp the apple and pick it up. Throughout this task, the visual system and the movement system are working in perfect harmony. The action of picking up the apple has been brought about by the interconnecting pathways of the dorsal stream. The picture was formed in the occipital lobes. It was mapped by the parietal lobes. The choice of the apple was made by the frontal lobes. The action was executed by the motor cortex and the whole system was interconnected by the dorsal stream.

[38] Cerebral Visual Impairment - Working Within and Around the Limitations of Vision; Gordon N Dutton; http://www.liv.ac.uk/~pcknox/Publications/trimble/CVI%20chapter%20for_hers-Dutton.pdf

The Ventral Stream

The ventral stream runs from the occipital lobes into the temporal lobes on each side. The temporal lobes contain the visual library. This library contains a general store of objects and shapes which enables us to recognise one object from another. There is also a special store of people's faces and a library of route finding methods both of which are usually located in the right side of the brain. When you walk down a busy street and recognise someone, your brain has accomplished a fantastic computing task for you. First, you probably know where you are going. Then, for every person you do not recognise, you compare the facial appearance of that person with your personal store of hundreds if not thousands of faces. When it does not match, you walk past that person. When you meet the person you recognise, you have a matching comparison which allows you to greet your friend. You were then able to recognise the facial expressions of your friend and to communicate accordingly. Children who have damage to the ventral stream can have difficulty differentiating one object from another and in particular, may have great difficulty recognising people's faces and differentiating different types of animals, one from another. They may be unable to recognise the language within facial expressions. In addition, route finding can be particularly difficult. This applies on a large scale when out and about and on a small scale within the home where, for example, it can be particularly difficult to know which drawer items are kept in.

It is clear that the dorsal stream and ventral stream pathways work in harmony with one another because we see and recognise, with our temporal lobes, what we choose to reach out and pick up using the dorsal stream, posterior parietal lobes. and motor and frontal cortex. However, when brain damage takes place, specific parts of these tasks are deficient and it can be difficult to understand why a child with such damage is able to see one thing but not another."

The description of posting a letter is the description for every Motoric Movement Action. So it is also the explanation for all actions in tennis. It is only a matter of finding the right perspective. Most of the time we approach this in an egocentric way. I want to post the letter. But that is not the perspective of the Motoric Movement Action. It is not the mailbox as well. The task of posting a letter must be approached from the perspective of the letter. Even not from the hand holding the letter. The letter must be placed into the action trajectory from the hand to the slit of the mailbox. A trajectory we can adjust because we can hold on to the letter. There for the perspective in tennis for the Motoric Movement Action is from the ball. The Motoric Movement Actions in tennis follow every step mentioned above.

So the task is from the perspective of the ball. The ball is glued to its ball trajectory and the Game Idea tells us that a player has to make chains of ball trajectories and try to prevent the opponent to continue this chain. A player has to receive an incoming ball trajectory and lead that to an outgoing ball trajectory with an optimal Game Intention. Based on the cognitive basis we can make a perceptual image of that task even while sitting in a comfortable chair at home.

If we actually are going to play the game we have to continually create tactical perceptions of the places where the ball will be in the near future. We can only achieve this task if we precisely predict how the shape of a ball trajectory globally will be. The game situation, cognitive knowledge about the execution of the Motoric Movement Actions of the opponent and the Initial Phase of the incoming ball trajectory will make that possible. Elite players decide in a very early stage where the incoming ball trajectory globally will be met and what outgoing ball trajectory will be created. Like in the posting task the ventral and dorsal stream check the images of perceptual ball trajectories from global to very refined. I will appoint this task completely in this book. This description will reveal very active perception processes related to the ball and the ball trajectories.

Now we switch to Joan Vickers. Joan Vickers invented the theory of The Quiet Eye (TQE). The results are not homonymous and there is a debate about it in scientific circles. But still these same scientific circles fully accept the theory.

TQE[39]: "Traditional visual search experiments, where the researcher pre-selects video-based scenes for the participant to respond to, shows that elite players make more efficient decisions than non-elites, but disagree on how they temporally regulate their gaze."

"1.2. Gaze control research in closed sports

Gaze control research has been carried out in closed skills such as the golf putt (Vickers, 1992), basketball shooting (Ripoll et al., 1986; Vickers, 1996), pistol and rifle shooting (Ripoll, Papin, Guezennec, & Verdy, 1985; Janelle et al., 2000), and billiards (Williams et al., 2002). Performers of these skills orient their gaze to a fixed target or target(s), such as the hole or ball in golf, the hoop in basketball, or the bullseye in shooting. Elite performers have a longer duration of final fixation on the target than near-elites (athletes with lower game statistics), and the duration of this fixation has been shown to be longer on successful than unsuccessful trials.
This object-oriented type of gaze control has been termed a ''quiet eye'' (QE; Vickers, 1996) and expert performers differ from non-experts in having an earlier onset and a longer duration of this gaze suggesting a sustained focus on one location or object is required prior to the initiation of the final movement. Williams et al. (2002) reduced the QE period experimentally in billiards and found that the accuracy of both elites and novice players declined as a function of the amount of reduction in the QE period. Harle and Vickers (2001) trained players to control the onset and duration of QE period in the basketball free throw, and their shooting accuracy improved in both the experimental and competitive setting. The QE period in closed skills has been deemed a perception–action variable, one that specifies the optimal regulation of the gaze relative to a final motor response (Janelle et al., 2000; Vickers,1996; Williams et al., 2002).

1.3. Gaze control in open skills

Research has also been carried out in interceptive-timing skills and sport tactics where the context is dynamic and influenced to a greater degree by external events than in closed skills. In interceptive timing skills where the flight of the object is predictable, an early onset of pursuit tracking on the object occurs, followed by a long duration of tracking which normally does not occur to contact (Bahill & LaRitz, 1984; Ripoll & Fleurance, 1988; Rodrigues et al., 2002; Shank & Haywood, 1987; Vickers & Adolphe, 1997; Vickers, Rodrigues, & Brown, 2002; Williams & Ward, 2003).
However, in skills where the flight of the object is unpredictable, such as in cricket batting, the elite batsman adjusts the gaze to deal with the uncertainty of late flight information. Land and McLeod (2000) found that while both low and high skilled cricket players tracked the ball as the ball was first delivered, only the highly skilled performer used a rapid anticipatory saccade to the bounce point, followed by a brief period of tracking before the ball was struck.
In open skills of an interceptive timing nature we therefore see that when the flight of the object is predictable, pursuit tracking is directed early to the object and over the first part of flight, but when the movement of objects is unpredictable then the gaze adapts to deal with late changes in object flight and it is the elite performer who is better at adapting the gaze so that the rapidly changing conditions can be perceived in time to effectively adjust the action."

[39] Gaze characteristics of elite and near-elite athletes in ice hockey defensive tactics; Stephen G. Martell; Joan N. Vickers. http://www.sciencedirect.com/science/article/pii/S0167945704000065

TQE doesn't see action trajectories. It doesn't see ball trajectories. TQE observes players aiming at something and for example assume that they throw the ball into the basket just like that. Without any guideline. By the way I have had the same idea once. So I can imagine that you research the amount of gaze players show. Because they don't see anything between the ball and the target. That is why gaze symbolizes executing a task without thinking. In most TQE research the target is only there as an active part of the gaze. Because there is only a ball and a goal.
The Game Action visualizes *a whole ball trajectory* between the two. This ball trajectory makes the task very *visible*. Or better the execution of the ball trajectory is the task. Because this task needs a lot of perception processes the head and upper body must remain as stable as possible. The head and the look of the eyes will quiet down due to this task. That is in great contrast with TQE. TQE turns around cause and effect out of the perspective of the Motoric Movement Action.

Sometimes a conclusion can be right but the contents can be wrong. Than it is possible that by reinforcing the conclusion you get better results. The head and upper body are as quiet as possible according to the Game Action. The eyes only make one saccade. That is because perception processes are very sensible to change. Gaze has positive effects on what is really going on. So gaze subjected research is very likely to show positive effects. So Joan Vickers is experiencing positive results and for her that proves the existence of TQE.

"The performance results supported our primary hypothesis, with QET children catching 23% more balls after training, compared to a 4% improvement for TT children"[40]

"QET and TT training interventions

Table 1 provides a summary of the content of the QET and TT instructional videos for the three phases of training. The QET videos were based on training the key QE behaviours uncovered by Wilson et al. (2013) for this task, and emphasized focusing gaze on an imaginary target on the wall prior to the throw, then continuously tracking the ball as it came towards them prior to the catch. The TT instructional videos were based on 'best practice' for learning throwing and catching and emphasized a smooth arm swing through to the release of the ball when throwing, followed by assuming a readiness position and holding the hands in front to cushion the ball during the catch (Bunker, Hardy, Smith, & Almond,1994)."

She doesn't only instruct to gaze but also gives the children set tasks. Although the tasks in catching approach the Game Action more than the throwing tasks both instructions instruct Self-1. They must be rejected both.

[40] Quiet eye training improves throw and catch performance in children Charlotte A.L. Miles a, Samuel J. Vine a, Greg Wood a, Joan N. Vickers b, Mark R. Wilson; http://www.researchgate.net/publication/262342333_Quiet_eye_training_improves_throw_and_catch_performance_in_children

However these tasks do address something. Maybe the positive result of this research is due to the fact that there has been given *a* task. And only *one* task. This fact is part of my proposition that flow and playing in the zone will occur if all focus processes are occupied by *one* ongoing task. In case of the Game Action the task even coincides with the Game Idea.

According to the Game Action it would have been better to improve the understanding of these children by showing the action trajectories between the children. These ball trajectories could have been shown on paper, video etc.. They should have been instructed that they can only influence the Initial Phase where the whole ball trajectory must be created. And that they have to throw the ball in the ball trajectory which is already there.
Children should learn that the catching follows the reverse path of throwing. They should learn to extend the Initial Phase of the ball trajectory and make perceptions of the latent part of the ball trajectory. They should learn to make precise predictions of the global area where they will have to catch the ball. Implicitly all the perception processes will be activated.

To address the cognitive basis I would surely let the children throw three reference ball trajectories[41]. A straight line, a 45° round ball trajectory and a 30° round ball trajectory. They are occurring a lot in throwing tasks and the shapes are very clear to every person. So the outcome of executed ball trajectories in an exercise will not lie[42]. Feedback will be accepted right away by a player. The reference ball trajectories will also be references for each other and because all the ball trajectories are actually used no time will be wasted on reference ball trajectories you will never use. In tennis nowadays this happens quite often with for example service exercises from the service line, the side line, the back of hall etc.. From an efficiency point of view it is important to use reference ball trajectories which have an independent use as well.

In that case I am sure that the results would have been a lot better with these children. I will prove that my take on the story is the most probable one. In retrospect one will have to conclude that TQE was a naïve linear explanation of the reality. All the perception processes need an explanation out of a complex system. And even if it will be proven that nobody is executing the Game Action than the explanation out of the complex system is the best representation of what should happen.

So the problem is spinning around the central question: "Is gaze the source of fulfilling the task (The Quiet Eye) or is gaze the consequence of fulfilling the task of the Game Action (The Active Eye). Or to put in in a different way do elite tennis players play the game with ball trajectories or not.

2. Flow and playing in the zone

Flow and playing in the zone[43] are closely connected to the previous paragraph. Every research and method in tennis seems to try to achieve these ultimate goals. Many claim to have found the only way. But until now the Game Action has not been fully appointed by nobody ever. So it was not possible to fully explain flow and playing in the zone. Now, for the first time in history, the Game Action explains

[41] Chapter 10.8
[42] Chapter 10.9; *Ball trajectories do not lie*
[43] Also see *Focus* (p. 30) and *The Motoric Movement Action and flow* (p. 59) in *Caught In A Line*

the whole Game Idea and appoints all the necessary actions a player has to fulfil. In here it is very important to notice that this explanation demands these actions out of the action itself. In other words those are the demands the body itself wants to be fulfilled.
Therefor the proposition is that flow and playing in the zone are only able to occur if the execution of the task of the Motoric Movement Action matches the task of the Game Idea completely. So instruction must only contain information which reinforces the Game Action. Other instruction will not make a contribution to flow. They will provoke *Self-1* to manifest itself and that will be detrimental to flow and playing in the zone.

The concrete task driven goal of the Game Action will ensure that not relevant information will be excluded. This is an essential different task then the task of just *watching the ball*. In just watching the ball there is no task whatsoever to find any information. One cannot maintain to execute that abstract task. One can only maintain a task if one needs to find information actively.

"In both studies we were struck by the rarity of eye movements to objects that were irrelevant to the task (see Fig. 1). The proportion of task-irrelevant objects viewed (other than during periods of waiting) was under 5% in both studies, even though, particularly in the tea-making task, there were numerous potential distractors. We conclude that — in real tasks — the eyes are driven much more by top-down information from the script, and rather little by the 'intrinsic salience' of objects (see Findlay & Walker, 1999). In one sandwich-making experiment involving four subjects 50% of the objects on the table were task-irrelevant (pliers, scotch tape, forks, etc.). In the interval before the task commenced, while the eyes were scanning the table, the proportion of irrelevant objects fixated was 52%. When the task started this reduced to 18%. Presumably this represented a shift from a salience-driven to a task-driven basis for selecting fixation targets.[44]"

[44] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities?

Chapter 3 – The Game Idea

1. Introduction

The Game Based Approach forces a sports discipline to appoint its Game Idea. It belongs to the justification of their existence. The Game Idea is needed as a premise to every definition in that discipline. It is the mother of all actions, methods, thoughts etc.. The appointing of the Game Idea is a crucial task.

In this chapter I will paint a picture of the historical development of the Game Idea and how it gave me the idea to develop it further. The development of the Game Idea moves from the perspective of the spectator to the perspective of the player to the perspective out of the ball. The Game Idea will be fully appointed by the Game Action. The perspective out of the ball was the missing and last link. There are no perspectives left.

From there I sketch the Game Idea in other sports. The new insights can be used in there as well. But the main goal of the sketch is to clarify the reasoning concerning the Game Idea in tennis further more. The parallel with other sports is that players intend to make chains of ball trajectories which must reach a goal in a certain way. Sometimes it is only about one part of a chain. For example the free throw in basketball or the penalty in soccer or field hockey. The only thing a player is able to influence in there is the Initial Phase of the ball trajectory. All the conditions a player wants at the end of a ball trajectory he has to insert during the phase when the ball trajectory is actually being created. Except for sports like curling.
In that way the end of a ball trajectory is known in the beginning and that is why we can say that a ball is tied to his trajectory. There is a mutual relationship. The ball shapes the ball trajectory but is also a passive part of it. It casts its shadow ahead. The actual place of the ball determines the sequence of actions to be made.
Another commonality is that the Game Idea can be taught to players for 100%. Which can't be said about technique and the application of technique. That is a matter of individual talent, physical ability etc.. The Game Idea can never be the limiting factor.
There is always a dualism in the Game Idea. One player has to lengthen the chain and the opponent must prevent that. In golf and darts there is no direct dualism. The player plays against the score of the opponent.

2. The Game Idea from the perspective of the spectator

The Game Idea in tennis used to be explained in a very simple way:

a. KNLTB: "The Game Idea in tennis is to hit and respectively hit back a ball with a racket over a net in the court of the opponent".

b. The Free Dictionary: 1. A game played with rackets and a light ball by two players or two pairs of players on a rectangular court, as of grass, clay, or asphalt, divided by a net. Also called lawn tennis. 2. Court tennis.

In these descriptions the Game Idea is appointed from the perspective of the spectator. It is logical that they describe the obvious visible actions one can see in tennis when you watch a tennis match. The hitting, the net, the court and a ball. No open skill sport. No perceptions and no decisions. And of course no ball trajectories or ball trajectory shapes.

In retrospect one can conclude that these descriptions reinforce Technique Approaches. A player mainly must be able to hit a ball well because naïve approaches think tennis is all about the hitting of a ball. The perspective of the spectator doesn't understand at all what a player is experiencing while playing the game standing on a court.

3. The Game Idea from the perspective of the player

The *old* Game Based Approach is the reflection of the Game Idea from the perspective of the player. At a certain point tennis was no longer evaluated as a closed skill sport but as an open skill sport. The insight grew that a player first needs to perceive in which game situation he is in and which answer out of a few options is the best one to choose. That is why two phases were added before the execution phase. The perception phase and the decision phase. In that way technique was permanently clung to tactics. In this approach tactics always precedes technique.

In retrospect we can conclude that the theory of the old Game Based Approach changed the perspective of the Game Idea from the spectator to the player. A coach had to stand virtually besides the player and had to understand how balls were approaching the player from that perspective. From now on a coach was supposed to act from this perspective.
The development of the this Game Idea can be seen as a step in the right direction. From the stands to a place on the court. It gave me the idea to bring it even further.

From this perspective we now can see what the player is facing when he is playing the game tactically. The understanding saw the light that there is a large variety of incoming ball trajectories. Even in the same game situation.
Although the development of this perspective was a very good one it gets stuck at a sudden moment. The Game Idea in this perspective is not appointed from the scoring in tennis and the ball trajectories. But the most important thing is that the open skill stays open all the time. The Actual Tennis Action shows that once a decision has been made for that one specific outgoing ball trajectory the skills are narrowed down to a situation where the technique must be applied in a very specific way. In contrast with the Technique Approach a player can still pick his own technique but he is limited much more than the *old* Game Based Approach hypothesized.

In retrospect one can very well see the linear[45] thinking approach in this perspective. The Game Idea out of the perspective of the ball shows that the whole process is much more complex. Perceptions of the latent parts of the incoming ball trajectory during the reception task have to continually be mixed with perceptions of the latent outgoing ball trajectory for the sending task. Even in the main phase of the swing of the racket a player still has to receive the ball which requires specific perception processes due to the Motoric Movement Action *catching*. A player in the earliest anticipation phase has to already make a global perception of the outgoing ball trajectory. This reference image is an important part of the actual hitting. The conclusion will be that a definite explanation can only be found in a description as a complex system.

4. The Game Idea from the perspective of the ball

The scoring in ball games is fascinating. Successful ball trajectories are converted in points. The scoring says nothing about the quality of a ball trajectory. You never get a point for the quality of the execution of a shot. In soccer an ugly goal has the same value as the goal of the year. The same applies to the marvelous winner at the end of a 30 stroke rally in tennis with a great built up and a few good saves. The stupid double fault following that point equalizes it completely. Maybe you get a little applause for that nice point. Happy you. But not an extra point. The scoring doesn't feel fair.

"the scoring system can be considered irrational and so on.[46]"

If you watch the black part of the DemoClip again than the scoring is only concerned about the fact if the chain of ball trajectories can be maintained. Only when the chain of ball trajectories is disrupted than that is the end of the Game Idea and that is honored with one point. The Game Idea from the perspective of the ball is about the connecting of ball trajectories till one player can't fulfil this task anymore. The player who is the last one to add a valid ball trajectory wins the point. Or the opponent wins a point when the chain has no valid first ball trajectory (double fault).
In this way the scoring will remain an abstraction. You actually don't score points but you are rewarded a point if you are the last player who was able to add the last ball trajectory. But an explanation like this brings it back to the heart of the matter.

The Game Idea combined with the scoring system tells a player to create chains of ball trajectories and to prevent the opponent doing that. The involved perception processes in these two tasks are continually working from begin to the end of one chain. There are two Motoric Movement Actions involved. A catching task and a throwing task. In tennis they must be combined. The throwing must directly follow the catching. So the perception processes for one action have consequences for the other action. The perceptions of the catching influence the throwing. And then the perceptions from the throwing influence the perception of the catching again in an ongoing process to the end of one chain. So while you actually lengthen the chain you have to try to prevent the opponent from doing that. So there are no linear processes. There is a continuous changing of the perceptions running in front of the actual ball trajectory and the actual checking if the ball complies with its destiny given to the ball during the Initial Phase.

"The Game Idea out of the perspective of the ball by just playing the ball towards each other is just to create long chains."

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[45] Chapter 1.7
[46] IL CERVELLO TENNISTICO (THE TENNIS BRAIN) Federico di Carlo

The Game Action is a complex system. This will be appointed in the Actual Tennis Action and the Tactical Tennis Action. If the game is actually played the technique will even make it more complex. The Game Action and the technique together create the full picture of the Game Based Approach. That is all what can be appointed.
By just playing the ball towards each other and especially with the *so-many-hits-rallies* out of the elite player manual of the KNLTB critical questions must be put towards these rallies. If the Game Idea would have been linear it wouldn't be such a big problem. But the perception processes are not linear and just playing towards each other disrupt these processes. There for they must be rejected. Making long chains can never be a legitimate goal in itself. Disconnecting parts of a complex system is very tricky.

In retrospect this perspective was not only a nice brain exercise. It explains the whole Game Idea from a complex system view. It covers all the other perspectives and there is nothing more what can be appointed. There is no perspective which gives such a full explanation of the reality. The model of the Game Based Approach gives a clear manual which can easily be implemented in daily practice.

5. The Game Idea and scientific research

Within the scientific world one also tries to find entrances to sports/tennis with a complex system as a basis. One particular research I want to mention here. I use it as an example for how scientific research tries to find complex explanations for the game of tennis.

Modelling the interaction in game sports – Relative phase and moving correlations – M. Lames[47].

Abstract

Model building in game sports should maintain the constitutive feature of this group of sports, the dynamic interaction process between the two parties. For single net/wall games relative phase is suggested to describe the positional interaction between the two players. 30 baseline rallies in tennis were examined and relative phase was calculated by Hilbert transform from the two time-series of lateral displacement and trajectory in the court respectively. Results showed that relative phase indicates some aspects of the tactical interaction in tennis.

Introduction

Game sports may be defined as those sports, where two parties (teams, doubles or single) try to achieve their goal and to avoid that the opponent achieves his one (Lames, 1991). This constitutes an interaction process, and the observable performance is rather the emergent result of this interaction process than the display of skills and abilities of the two parties.

[47] J Sports Science Med, 2006;5: 556-560. http://www.ncbi. nlm.nih.gov/pmc/articles/PMC3861755/

One point of criticism is the perspective of the research. Most research considers the perspective of the spectator and sometimes the perspective of the player. They never consider the perspective of the game itself.
From this open complex model researchers especially are exploring the open dynamic parts of a sport. However the Actual Sports Action imposes a lot of limitations. You have to actually execute actions in a very strict way according to the Tactical Sports Action. Then the sport demands a really closed execution of one trajectory.

Relative Phase in Tennis

"The idea of describing movements of two players with their relative phase was first introduced by McGarry et al., 1999 in squash. They were influenced by an interpretation of the players' moves as the moves of a dancing couple. Certainly, another source of this idea was the successful application of relative phase in order to describe coordinative patterns in movement science (Haken et al., 1985; Kelso, 1995). McGarry et al., 1999 examined the absolute distance of the players from mid-court and found dominantly an anti-phase behaviour. Palut and Zanone, 2005 calculated relative phase for the first time with Hilbert transform. They used the lateral distance from mid-court in tennis and also found that most of the time, tennis players showed an anti-phase behaviour, but also in-phase values of relative phase showed a relative maximum."

"Why is relative phase a promising approach to describe the spatial interactions in a net/wall game? From a systems point of view, the movements in tennis can be perceived as the movements of two subsystems, the players. These subsystems are strongly coupled by the nature of the game because they exchange strokes. While one player hits, the other tries to get in a "neutral "position, from where he has the best opportunities to arrive in time at the next stroke. As soon as he recognizes the direction of the stroke, he moves to the place of contact, while the other player moves to his "neutral "position. Figure 1 displays an idealised long-line and cross rally with the corresponding positions."

Of course there is interaction. Players are attached to each other in chains of ball trajectories. Compared to the Game Action this explanation is a rather naïve description of reality.

"A very interesting hypothesis from a practical point of view is the relation between the relative phase and the state of the rally. One might assume that a stable relative phase indicates a stable game when no player has problems to arrive just in time for his stroke. The very nature of tennis demands, though, to use placement and speed of the strokes to create pressure and win the point at last. This should result in a perturbation of relative phase. So, the hypothesis is that in a stable phase of the rally the relative phase is stable, but in the final phase, when a winner is scored or the opponent is forced to commit an error, the relative phase becomes unstable. If this hypothesis could be proven it would allow to determine the pressure created during a rally which would in turn be a valuable instrument for practical analyses."

Again a naive description of reality. Within the dualism of the Game Idea one can distinguish ball trajectories and ball trajectory defining factors (BTDF)[48]. The BTDF contain the factors *tempo* and *pressure*. Losing/winning the tempo in a tennis rally explains the differences in relative phase. If unforced errors are not involved a rally usually develops from winning the tempo to dosed finishing of the rally. This dosed finishing will lead to a gradually increasing profit of the tempo. Till finally the point is scored. The player who dictates the tempo will gradually get more and more time to complete his actions. The opponent will experience the reverse effect.

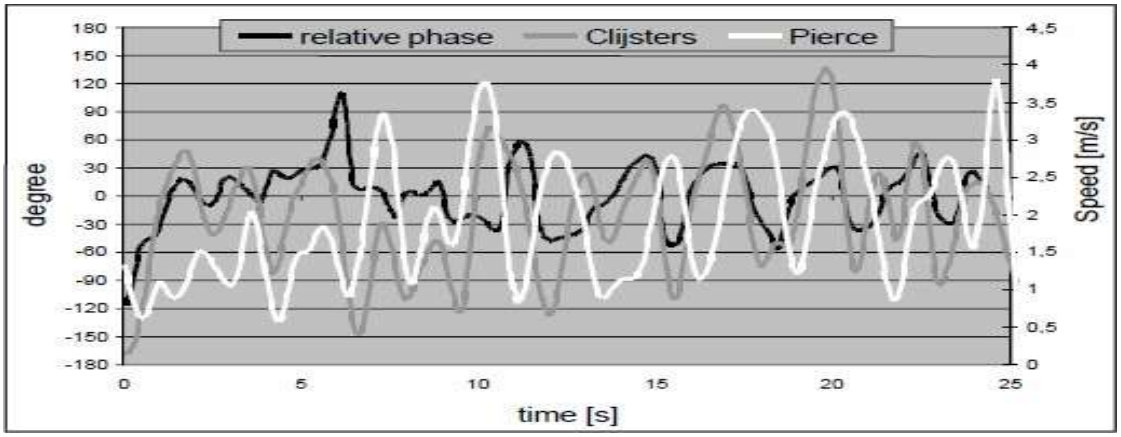


Image: *figure 3*

> *"As an alternative we took the players' trajectory in the court from measurement to measurement (25 Hz). Actually these are speed data and relative phase now informs about the phase relation of moving speed of the players independent from their position on the court. With this data we usually get clear results for relative phase but we lack much of the understanding what is going on in the court (see Figure 3). As a result, we suggest analysing lateral displacement as well as the two-dimensional trajectories in the court."*

It is striking that very abstract movement patterns are appointed but that the very concrete *visible* ball trajectories aren't noticed.

> *"Results concerning the distribution of relative phase show that taking speed data we obtain a one-peak distribution indicating the dominance of in-phase. This is due to the fact that the rally synchronises the players in the sense that they alternate between two states: low speed while one player hits and the other orients for his next stroke, high speed while one player approaches the ball for his next stroke and the other comes back from his stroke towards a neutral position. This is in good agreement with the findings of Palut and Zanone, 2005."*

Of course the interaction is there. Players are glued to each other in ball trajectories. A player is forced to use the end of a ball trajectory to lengthen the chain. In addition to that matter you can notice that Ball Reaching Footwork (BRF) and Court Defending Footwork (CDF) show different dynamics.

> *"If this notion of game sports as dynamic interaction processes is accepted, two important consequences are to be drawn. First, some of the traditional methods*

[48] Chapter 1.3

> *of performance analysis in sports science become doubtful. For example, the search for behavioural norms becomes a futile endeavour if behaviour changes dynamically and emerges from the singular encounter of the two opponents. Also, assessing individual skill in game sports will remain a problem as long as the measures used add up (weighted) frequencies of observed behaviour and do not respect the singularity and dynamics of an interaction process. The second consequence is that this notion stimulates the search for new models which are capable to describe the crucial properties of game sports, interaction and dynamics."*

I completely agree with the last sentence and so I did with "Watch The Ball Trajectory!". But this kind of research is much too complex to be used in daily practice. I can't imagine any way to get this kind of research translated to a player.

6. Ballgames and the Game Idea

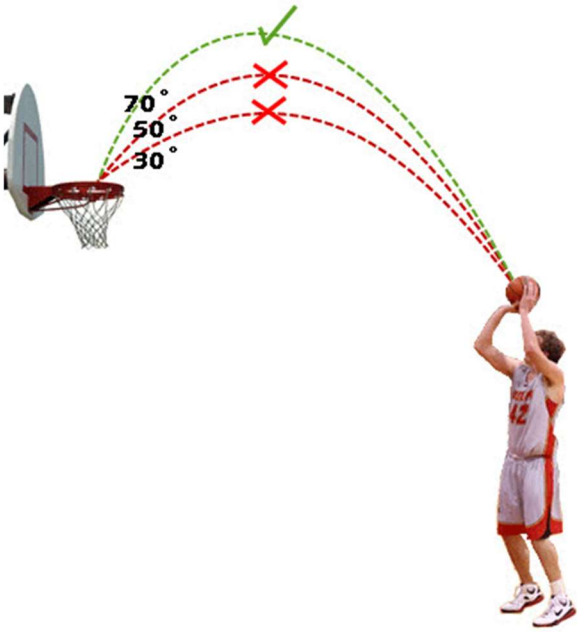
I consider all sports ballgames where the goal is to create a trajectory with an object. So that also includes darts, curling, badminton etc..

I will discuss a lot of sports to give a reference frame to the Game Idea in tennis. Besides that one can see that the explanation out of the Game Idea stays intact in all sports. A complex system explanation must be universal.

In this paragraph I will classify sports and game situations in such a way that their relation to the Game Idea will become more clear. I will start to appoint the sports and game situations with the least complex ball trajectories and end with the sports with the most complex ball trajectories and variety possibilities. An enormous range of complexity can be determined. The height of complexity will answer the question if that sport will be able to train the Game Idea separately in an effective way. Tennis finds itself somewhere in the middle. The variety and complexity of ball trajectories in tennis are limited to very limited. The Game Action can be trained separately in a very effective way.
A connection in all ballgames (except for curling) is that a player is only able to influence the beginning of the ball trajectory. There they have to construct an initial ball trajectory which will contain all the premises that will finally guarantee the whole shape of the ball trajectory. Another comparison is the fact that only the place of the ball is fulfilling the Game Idea and that technique is not involved. Even if it is related to open skill sports with a perception, a decision and an execution. The execution doesn't relate to technique but to the realization of a ball trajectory. The Game Idea appoints the game and not the actual gameplay.

6.1 The free throw in basketball[49]

The Game Idea in the free throw or the jump shot in basketball is to make a perceptual ball trajectory from the hand to the basket and throw the ball into that perception of the ball trajectory during the Initial Phase. The game situation is special because of the ball being in close range of the eyes. The same can be said about darts and the volley in tennis.



A basketball player has a cognitive image of the task. This image originates from the cognitive basis. At the moment of the throw he compares the stored information with the actual image of the surroundings. A by-product from this is that distracting information is removed. The player then makes one specific ball trajectory to this one specific basket. F.e. the basket can vary in height or there is a transparent backboard. Then he visualizes the ball trajectory which will lead to a successful task fulfilment.

Basketball players check the ball trajectory linking the ball to the basket a few times and then throw the ball not in the basket but in the beginning of a successful ball trajectory. That is the Initial Phase of the ball trajectory. That is the only piece of the ball trajectory players can control. The Initial Phase is longer than in tennis because there is only a throwing action involved. A player can adjust the Initial Phase for a relative long time. So the outcome of the perceptions towards the ventral and dorsal stream

[49] There is a lot of scientific research concerning the free throw and jump shot in basketball.
a. Training quiet eye improves accuracy in the basketball free throw; Joan N Vickers; The University of Calgary
http://www.researchgate.net/publication/232452867_Training_quiet_eye_improves_accuracy_in_the_basketball_free_throw
b. Aiming at a far target under different viewing conditions: Visual control in basketball jump shooting; Raoul R.D. Oudejans *,Rolf W. van de Langenberg, R.I. (Vana) Hutter
https://www.basketball.nl/media/algemeen/cto/kenniscentrum/oudejansetal2002.pdf
c. Basketball Jump Shooting Is Controlled Online by Vision; R. Ferraz de Oliveira, R.Huys, R.R.D. Oudejans, R.van de Langenberg, P.J. Beek
http://www.researchgate.net/publication/6115479_Basketball_Jump_Shooting_Is_Controlled_Online_by_Vision
d. Effects of Actions Preceding the Jump Shot on Gaze Behavior and Shooting Performance in Elite Female Basketball Players by Raôul R. D. Oudejans, Rajiv S. Karamat and Maarten H. Stolk
http://www.basketball.nl/media/algemeen/cto/kenniscentrum/Oudejansetal2012IJSSC.pdf

are active much longer. A player can hold on to the ball for approximately 0,5 meters. From the beginning of the Initial Phase a latter part of the Initial Phase is still latent. The ventral stream makes a perception of that latent part. The dorsal stream corrects possible deviations in an ongoing mutual process with the ventral stream till the ball is released.
The ball trajectory forces the ball to go into the basket. This means that a player can leave reality and only focus on the perception of the Initial Phase close to his hand after the last time he checked the virtual ball trajectory. A basketball player is able to perform that with the eyes closed. He doesn't need to keep gazing the way Vickers (TQE) states. Michael Johnson proves that on YouTube[50].

6.2 Golf

The Game Idea is executed by the ball and not by the player. The same applies to golf. The player influences the ball and complies to the Game Idea in that way. But only in that order and these strict boundaries.

Image: A *par 4* hole: 3 ball trajectories through the air to the green and a final ball trajectory along the ground to the hole.

The Game Idea in golf for a par 4 stroke looks like this. From the tee four ball trajectories without seeing a player. Now you must try to make a perception of ball trajectories like in the DemoClip. Ball trajectories in curves without a player visible. The first two ball trajectories will be relatively long. Dependent on the shape of the golf course the Tactical Golf Action takes its role. The third ball trajectory will probably land on the green. And the last ball trajectory must be a *put* in the hole. Four ball trajectories without any hit to be seen. From the tee to the end of ball trajectory 1, from the end of ball trajectory 1 to the end of ball trajectory 2, from the end of ball trajectory 2 to the end of ball trajectory 3 and from the end of ball trajectory 3 to the hole. That is the Game Idea out of the perspective of the ball. The most important thing to be noticed here is that chains of ball trajectories are formed for one hole. When one hole is finished the chain stops. The new chain starts at the next tee.

[50] https://www.youtube.com/watch?v=_JUjbpL9X7I

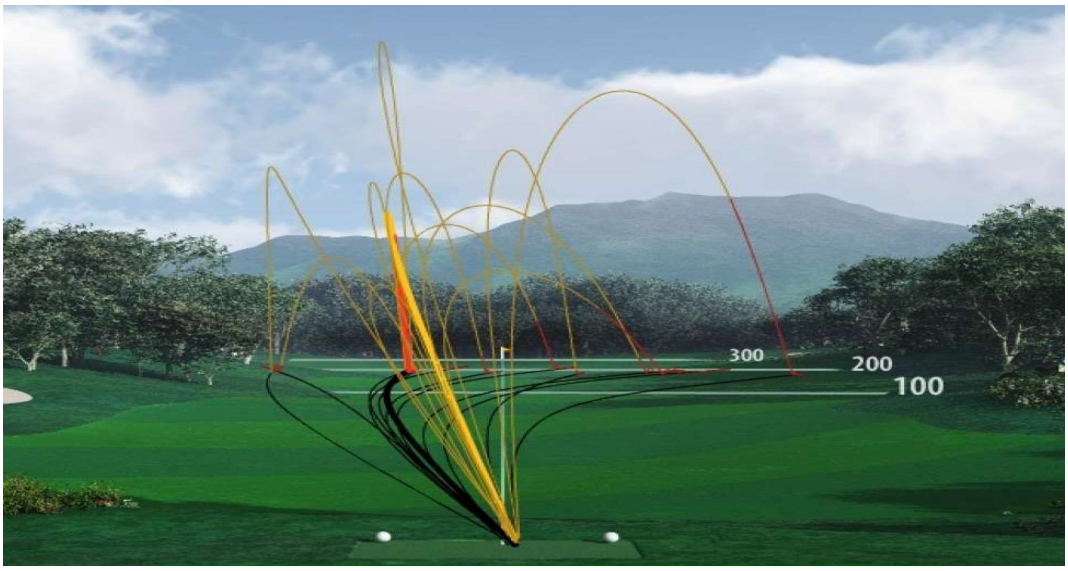


Image: In golf they created ball trackers[51] like IBM did with PointTracker. They are very informative concerning shapes of ball trajectories in golf.

6.3 Billiard sports

Billiard sports are part of those sports who classically play the game in ball trajectories. The player knows that he can only influence the first part of the ball trajectory. During the Initial Phase the ball is manipulated in such a way that it will fulfill the desired ball trajectory.
In billiard sports there are different *Diamond systems*. They approach the game from the perspective of ball trajectories. The Tactical Billiard Action will consider all possibilities. A carambola must be made or a ball must be pot.

After that the white ball has to maintain good position to continue the rally. Out of the many opportunities the Actual Billiard Action can only decide to make just one ball trajectory. And only that one specific ball trajectory can and must be created. So it is out of the question to create a ball trajectory with a little bit of this and a little bit of that.
So again the Game Idea in here follows the universal Game Idea. A player needs to create chains of (white) ball trajectories until the frame is finished. There is a direct game dualism. Although a player is always able to place the ball in an ideal spot for the next shot he must consider the consequences of that spot if he will miss the next outgoing ball trajectory. Just like in tennis a player has the direct task to prevent the opponent from making long chains. That part of the Game Idea is clearly to be soon in a game like snooker.
Although there is a direct game dualism an opponent is not able to actually influence your action trajectories. The same principle goes for all sports which connect playing areas exclusively to only one player or only one team. So in that way tennis and volleyball differ a lot from team sports where physical contact is allowed.

[51] https://www.youtube.com/watch?v=K6AZr5rC6UQ

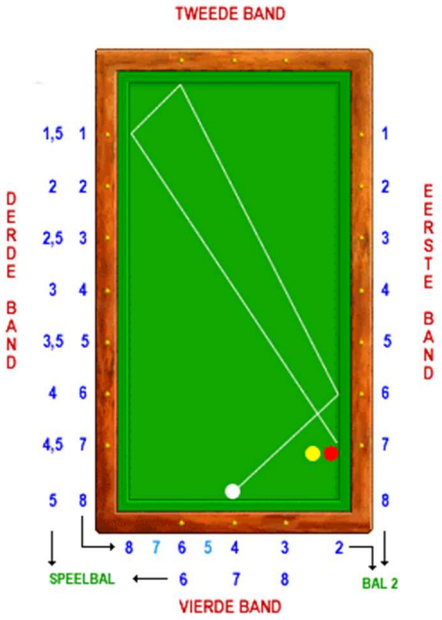


Image: Billiard with *diamond* dots on the cushions

6.4 The penalty in soccer

One part of the Game Idea in the penalty in soccer is to make a ball trajectory from the penalty spot to a place in the goal over the goal line (throwing task). But don't forget that there is another part of the Game Idea. There is a direct game dualism in this game situation. The Game Idea for the goal keeper is to try to prevent this ball trajectory to reach the goal (catching task). So like in the DemoClip the Game Idea is only concerned about the ball trajectory.

The Game Action in the penalty in soccer has two main strategy possibilities for the player:

a. Don't wait for reactions of the goal keeper

The penalty manual states that a penalty can't be stopped if you aim for a spot a keeper's length away from the keeper. If a player visualizes a ball trajectory to such a spot that must be sufficient. A player then only has to make the ball trajectory. Just like the basketball player he checks the virtual ball trajectory a few times. If a player is actually going to execute the penalty the player has to get his attention to the ball. The only part a player can influence is the first part of the ball trajectory. There he has to kick the ball into the perception of the ball trajectory. During the Initial Phase of a ball trajectory.

b. Wait for reactions of the goal keeper

Goal keepers know that if they react once the *perfect* penalty has been kicked they are too late. Keepers know they have to react at a certain time. If a player dares to wait till the keeper moves he must at least have two ball trajectories ready to perform. Of course that is more difficult but if the keeper chooses a side than the ball trajectory will not demand the same quality as in the other strategy.
This last situation is also known in tennis. On a regular basis we let players, who come back running out of a corner (Court Defending Footwork), choose a side. The strategy then is to make an outgoing ball trajectory far in the 2nd tempo and wait for the opponent's choice just like in this second option.

However in the line-up of sports in this paragraph this is the first sports(-situation) with a direct game dualism where an opponent will be able to actually deviate your intended action trajectory. That is why it is in this place. Most people regard a penalty kick out of the perspective of a player only and not out of the perspective of a goal keeper. But the Game Idea out of the perspective of the goal keeper is the equal task as it is to the player. If you want to formulate the task for a goal keeper in an easy way you can say that the task for a goal keeper is to prevent a player from fulfilling his goal. It would be more specific to appoint the full recipe of the Motoric Movement Action *catching*[52] in here. You can apply the blueprint of catching 1:1 to the task of the goal keeper. I will not appoint it any further in here. In here it is enough that you see that there is an equal direct game dualism and that the player needs to fulfil a throwing task and the goal keeper needs to fulfil a catching task.

6.5 Batting sports

The Game Idea in batting sports only concerns one cycle of a chain. A player has to create one outgoing ball trajectory to one incoming ball trajectory with a bat. The Game Idea of the pitching opponent is to prevent the player from creating an outgoing ball trajectory or to take care of the fact that either the outgoing ball trajectory is very short or can be caught.
The difficulty of the game is situated in the fact that the ball is thrown with high velocities, that the pitcher is relatively close to the batter and that in case of cricket the outgoing ball trajectory must be produced out of the 1st tempo (a line coming upwards) most of the time. The reception of the incoming ball trajectory is much more crucial than the creation of the outgoing ball trajectory. The saccade of the eye needs an amount of time. In these sports this action is under real time pressure.

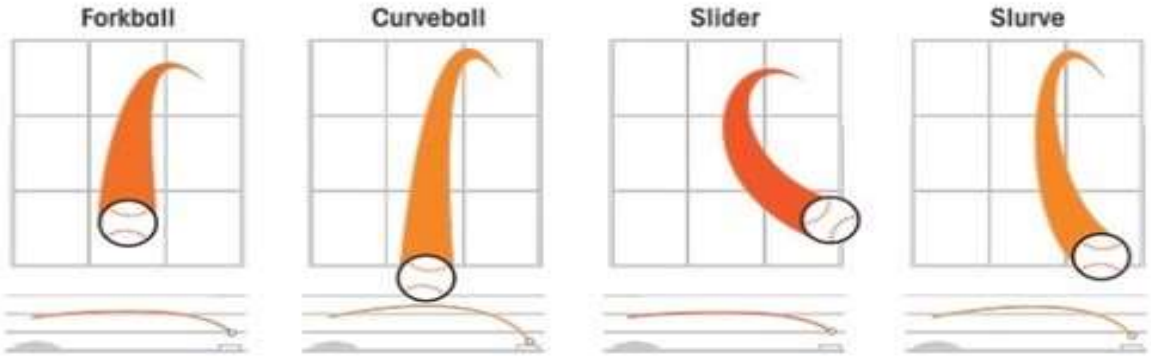


Image: a few examples of *reference ball trajectories* in baseball

[52] Chapter 5.2a

The saccade must be made because in batting sports two Motoric Movement Actions are combined. The hitting can only be performed successfully if the reception meets certain standards. The Initial Phase of the incoming ball trajectory will precisely tell where the ball will globally give intersection points with possible outgoing ball trajectories. An elite player needs that information. It narrows down a lot of possibilities. Otherwise it becomes gambling. Once there is enough information about the global area where intersection points can be made an elite player will transition to the sending phase. His eyes make the saccade and go to the area where the beginning of the Initial Phase of the outgoing ball trajectory is globally planned. With his peripheral vision he can see the ball and allows the ball coming towards the perception of the intersection point. Even when his bat is already in the main phase of the swing. When the first Motoric Movement Action *catching* is so hard to fulfil like in batting sports the second Motoric Movement Action *throwing* will get less attention.

Tennis is familiar with a similar situation. The return on service (ROS) against serve specialists can be compared with cricket very well. From the appointing of the Game Idea and the Game Action one can now start to look for strategies where the catching can benefit most in order to achieve the highest success rates. A lot of coaches still want players, even facing very fast services, to step in and take their bodyweight into the ball. That is a very bad strategy. There is an end to returning a very fast incoming ball trajectory with an even faster outgoing ball trajectory. Services belonging to a player like Ivo Karlovic should be treated like cricket pitches.

Players should practice the return on service universally. They must gain enormous insights in the special shapes of the first incoming ball trajectory. It must become a part of the cognitive base. An actual incoming ball trajectory of a service needs to be compared with a perception of a reference ball trajectory. Later on elite players need to train opponent specific. Elite players (<200 ATP-WTA) are able to really benefit from an *image library* of at least the serve specialists in the circuit. This library has to contain video clips with clips of incoming ball trajectories preferably out the perspective of the actual position of the returner. A player must be able to consult this library during his preparation for the next day. The player will then be able to prepare to the opponent specific ball trajectories and the opponent specific body characteristics while performing the Motoric Movement Action of the service. Body specific features could be highlighted with colours.

6.6 Tennis

In the classification of the Game Idea tennis is just behind hitting sports. The ball trajectories are more complex. In hitting sports a player doesn't need to move like a tennis player does. Tennis contains longer chains of ball trajectories. In hitting sports there are no chains and patterns of play.
Tennis compared to team sports like soccer, basketball and handball is far more limited in ball trajectory possibilities.

6.7 Volleyball

The Game Idea from the perspective out of the ball is to make chains like in tennis. However it is allowed to add three ball trajectories before the opponent has to lengthen the chain. Just like in tennis a player must prevent the opponent to continue the chain.
Volleyball, from the perspective of the Game Idea towards ball trajectories, is a little more complicated than tennis. Tennis dominates in speed and shapes of ball trajectories but the combination patterns with six players make volleyball more complex.
Still volleyball can be trained out of the Game Idea very well. Smashes out of the 1st or 2nd tempo can be preceded by set patterns. Patterns are far more limited than patterns in team sports mentioned in the paragraphs 6.8 and 6.9.

6.8 Team sports like soccer, basketball, handball, field hockey

In these sports the Game Idea is to make chains of ball trajectories. The end of the last ball trajectory in a chain must reach the goal of an opponent. The opponent must prevent the chain from reaching the goal. There is a direct game dualism with a larger number of players (5-11) trying to fulfil these two tasks. These sports contain much more possibilities in ball trajectories than volleyball. Volleyball is nicely separated from the opponent with a net. That net leads, like in tennis, to a much more structured process.
That is not the case with the team sports in here. Within a few seconds the ball trajectory matrix becomes much too complex and can only be controlled in set game situations. Ball trajectories in these sports can be made back and forth. There are many team members who are also allowed to move. A player is allowed to make endless ball trajectories with himself as the destination. In these sports the Game Idea can only be practiced in a limited way. The team is able to practice patterns but they will very soon experience limitations because of the many options possible. Then the matrix becomes too complex.

6.9 Rugby ball sports

These sports follow the team sports under 6.8. Before the bounce the ball behaves in a normal way. Of course after the bounce that is quite different. To make patterns possible players must prevent the ball from bouncing or to let the ball bounce in a predictable way. The conversion follows the free throw in basketball.

Chapter 4 – Elite players experience the game in ball trajectories

1. Introduction
2. Perception research
3. Perceptual Organistaion
4. The Tweener
5. Federer serves with his eyes closed
6. Quotes
7. Feeding a 45° round ball trajectory
8. Empiric experience
9. Pong

1. Introduction

With every Motoric Movement Action you actually fulfil one action trajectory. Out of the uncountable possibilities of latent action trajectories in every environment. You can imagine all these latent action trajectories as a constant existing *matrix.* Where ever you are the matrix is there. Lucky for us the matrix is not visible. It would drive you crazy.

"Locating. On entering the kitchen each of our three tea-making subjects spent an initial period of about half a minute looking around the room, with gaze resting on objects that would subsequently be used in the task. During the tea-making task, which typically lasted about 4 min, there were several other periods of similar behaviour each lasting a few seconds. During this 'surveying' behaviour the location of some objects to be used in the future was established. This was evident from the fact that subjects oriented accurately to objects behind them, when these had been fixated a minute or more earlier. In another example, the milk was located in the fridge, although it was not removed until over a minute later. Thus some fixations are concerned with establishing the locations of objects, even though there is no associated motor activity at the time of the fixation.[53]"

The trajectories are always there. Even if one day we decide to make really different action trajectories. A zigzag movement to the light switch. It doesn't make a difference. The hand shapes one line for one Motoric Movement Action. The same applies to a ball. A moving ball is always bound to one ball trajectory. Even if one day it decides to move in a very strange way.

However we are not aware of these action trajectories. It is not necessary. Most daily Motoric Movement Actions are very simple. So even if I prove that you make an action trajectory towards the light switch it will not help you any better in daily activities. Still I know that we implicitly perceive the world in action trajectories. In a tea making task researchers looked at visual perception patterns of participants in a scientific research. Every object and location what was next on the what to do list was fixated a moment earlier.

[53] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities?

In a tea making task we scan the room for all the actions we have to make. It is very important to know if we can fulfil a task from the place where we stand or if we have to move our hands first with our legs. We also look how we have to approach an object with our hands. In here it is very important to notice that we also look if the action trajectory is not occupied. We also check the distance once more and we make a definitive picture of the action trajectory involved but we mainly look if the action trajectory is not occupied by other objects. This looking at *nothing* is a very important goal of the perception processes. Because *nothing* is there researchers never noticed this important aspect. But the goal of the fixations is to also perceive *nothing* disturbing the action trajectory to be made. We don't want to hit a cup of hot tea of the table while reaching for the sugar. In daily traffic this is the main thing we do as participants. Using the free parts of action trajectories of our Motoric Movement Actions in relationship to free parts of action trajectories of other participants in the same traffic environment. I will extensively discuss this part in my book about the Motoric Movement Action[54].

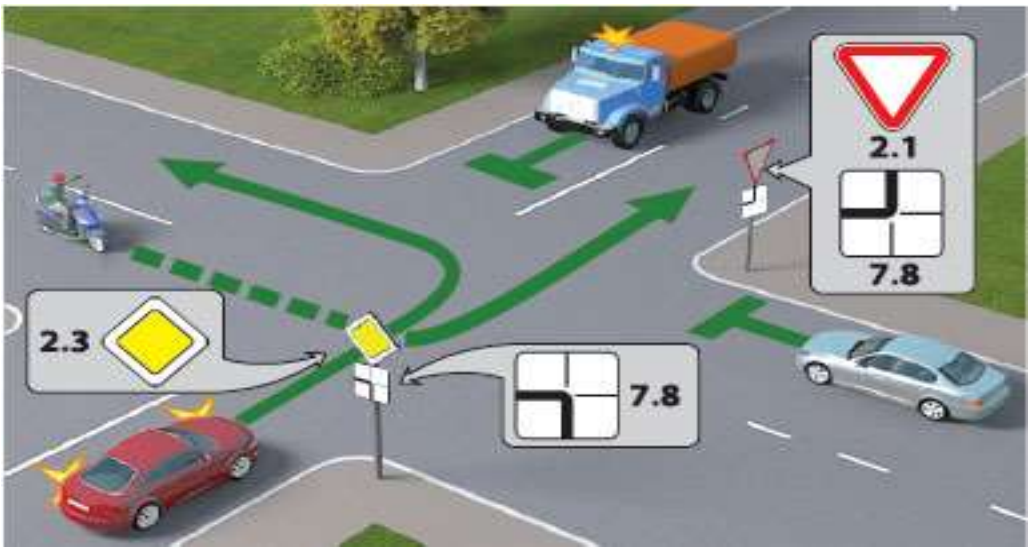


Image: Four motor vehicles with *conflicting* latent parts of the action trajectories. Some drivers will have to either change the shape of the action trajectory or the timing of the action trajectory.

"Directing. Many actions begin with a movement of the hand to contact an object. These are nearly always preceded by a fixation on the object (there were one or two cases where an object was contacted while the eyes were looking elsewhere; presumably this was done from memory). Typically only a single fixation is involved, and the eye usually moves away from the object just before the hand reaches it. Thus the grasp itself is often not executed under visual feedback. It seems that the main function of the directing fixation is to provide fovea-centred goal-position information for the motor system of the arm, which then concludes the movement in a (visually) open-loop manner. Some information about the shape of the object to be grasped is probably also obtained, as the hand 'preshapes' on its way to the target. Another example of a directing movement is putting an object down. As in grasping it is the destination that is fixated, in this case the place on the bench or shelf where the object will be put down.[55]"

In ball games the Motoric Movement Actions are far more complex. Tennis belongs to the top of the most complicated Motoric Movement Actions. In tennis we also don't perceive the tennis environment explicitly in ball trajectories. Ball trajectories are the action trajectories in tennis.

[54] Caught In A Line ~ *The Motoric Movement Action*; N.J. Mol – November 2016
[55] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities?

That ball trajectories exist has been proven with the DemoClip but do elite players really use them? As a beginner I am sure that you and I didn't use ball trajectories. And Federer as well. Although he might be the exception. Maybe he was born in the *tennis matrix*.

It is my proposition that elite players constructed this themselves based on the input of conventional lessons. Because there doesn't exist any method which implicitly or explicitly teach players to play in ball trajectories. One can only determine that most methods allow players to perceive the game in ball trajectories.

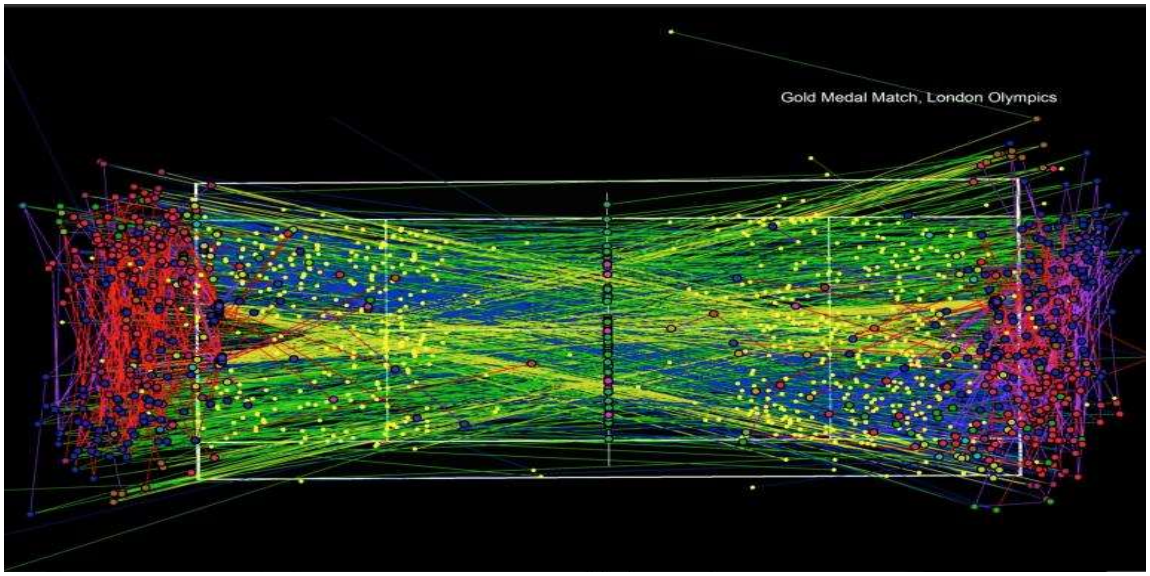


Image: An impression of how a *tennis matrix* could look like. Ball trajectories and movement patterns in the match Federer-Murray (finals OS London).

In this chapter I am going to prove that elite players play the game in ball trajectories. Although only scientific research will have the final word. But be aware that the *old* Game Based Approach hasn't been scientifically proven as well. On logical grounds we take for granted that it is the best explanation of reality. I will follow the same path.
Besides the evidence in this chapter there is a huge amount of circumstantial evidence in the other chapters of this book. The Actual Tennis Action, the Tactical Tennis Action and the Game Action are all congruent with actions which can be seen in match play of elite players. The DemoClip is a reality as well. And the Game Idea can be applied universally to all sports. Even more so the Game Idea can be applied to all Motoric Movement Actions[56].
All the evidence together is so overwhelming and uniform that further research is not really necessary for me. But if research should demonstrate that nobody plays the game in ball trajectories than I show with this book that it must become the basis for all new methods.

2. Perception research

   a. Visual Perception and Action in Sport
   b. The Role of Internal Models and Prediction in Catching Balls
   c. The Visual Brain in Action
   d. Tussen de linies spelen

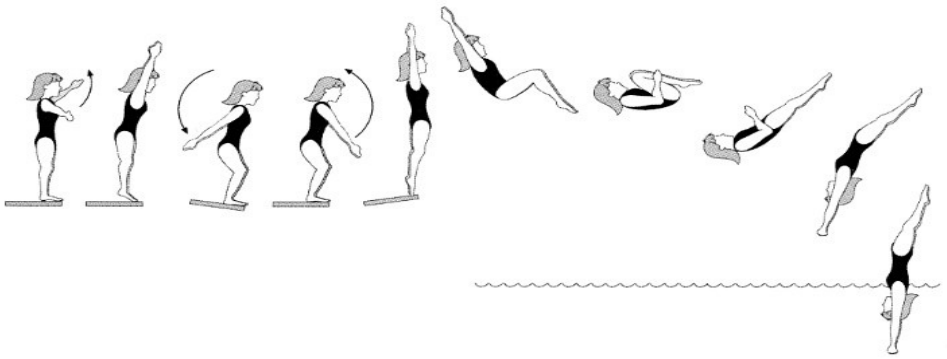
[56] See *Caught In A Line* – The Motoric Movement Action – The explanatory model of all motoric movements

There is no scientific research which appoints the Game Idea out of the perspective of the ball. Researchers look at the tasks from an egocentric perspective of a person. From an urge to act. I want to post this letter. I want to kick the ball in the goal. I want to walk to school. I want to bake an egg. I have to make an outgoing ball trajectory on this incoming ball trajectory. That is the wrong perspective if you want to explain the game.

In every Motoric Movement Action one makes an action trajectory with the body, a body part or an object. In the Motoric Movement Actions catching and throwing the object we are catching or throwing makes the action trajectory[57]. The perspective must be taken from the *object* that fulfils the task. When posting a letter the action trajectory is from the letter (not the hand) to the slit of the mailbox. To open a waste basket with the foot the action trajectory is from the foot to the opening device. In walking the action trajectory is the trajectory the whole body makes from A to B.

When I am in a kitchen environment my body, body parts and objects I am holding make latent action trajectories towards all objects in the kitchen. A matrix of potential options. They will only become manifest if from an egocentric will they are converted into actual actions. So if I want to bake an omelette from my right hand to the fridge will occur actual action trajectories to get the butter and eggs. From the left hand I reach for a pan. With my foot I open the waste basket and with one cool move of my bum I close the fridge.

And that is the way it happens in free diving as well. A diver is now the ball in a ball trajectory. She dives into the cognitive trained and at the moment perceptually visualized trajectory. In case of walking or diving one can adjust the trajectory while making it. The Tactical *Dive* Action has made a decision for one trajectory before the actual action happens. The Actual *Dive* Action corrects this perception, like explained in chapter 2, in an ongoing mutual process. That is necessary because the jump into the trajectory from a board is always instable. The Actual Dive Action becomes really evident in the last phase of the dive when a diver needs to find the opening to the water. That has to be timed through a perfect cooperation between the perceptual perception and the actual perception.



And that is also the way it works at a tennis court. A player relates to everything at the court in latent action trajectories. Usually a player is only going to play the game of tennis and limits himself to the Game Action. So you don't talk to the public, you don't make rude gestures and you don't throw with your racket.

There is no scientific research yet concerning the Game Action. Therefor there is no real evidence. However existing research is acknowledging all the findings in the Game Action. In the next sections I mention a few research papers which will paint a clearer picture.

[57] Chapter 5.2

a. Visual Perception and Action in Sport[58]

"That is, the ventral stream permits the formation of perceptual and cognitive representations which embody the enduring characteristics of objects and their spatial relations with each other, whereas transformations carried out in the dorsal stream, which utilise the instantaneous and egocentric features of objects, mediate the control of visuomotor actions. Furthermore, they contend that neither stream works in isolation but they engage in extensive orchestration.

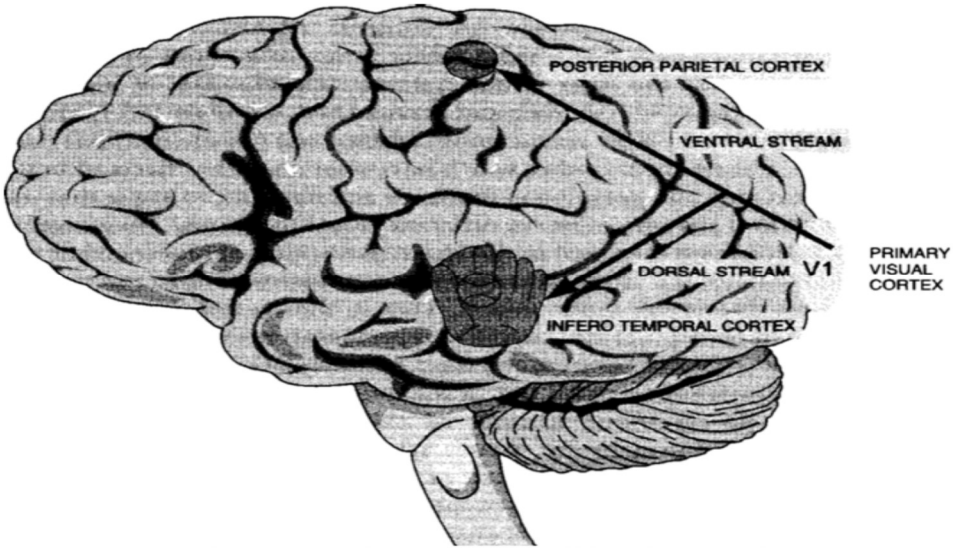


Figure 3.7 Two main streams of visual processing in the cortex. According to Milner and Goodale (1995), the ventral stream to the posterior parietal area plays a major role in object recognition and the dorsal stream to the inferotemporal region is involved with the 'on-line' control of goal-directed action as depicted by the object (baseball) and the catching action (ball-glove relationship). Despite the apparent independence of the two streams, coordinated action is dependent upon a higher degree of cooperation between the two pathways."

"It is important to note that the successful selection of the correct movement programme is dependent on skilled perception of ball flight characteristics. Abernethy and colleagues (e.g. Abernethy 1981, 1987a, 1987b; Abernethy and Russell 1984) have pointed out that the time constraints of fast ball sports are so restrictive at the highest levels of performance that it is not feasible to readily modify the duration of parts of the movement (e.g. quicken one phase of a biphasic batting action). This type of variability would increase the programming demands upon the performer. Rather, the skilled athlete is one who 'buys' time by exploiting the advance signals emitted by the movements of opponents for decision-making and preparation of a response. Skill in rapid interceptive actions, such as catching and hitting a ball, is based upon the ability to detect and interpret perceptual information through a comparison with an internalised memory structure based on past experiences in similar situations. Top class players have developed highly sophisticated models of the world which allow them to predict events and to select pre-programmed sequences of movements specifically designed to carry out interceptive tasks. This explains why skilled athletes never seem to merely react to unexpected events, but appear to operate in the future. They use an 'anticipatory mode' of action (Whiting, Alderson and Sanderson 1973)."

[58] Williams, A.M., Davids,K., Garrett, J.; p.78; http://www.imd.inder.cu/adjuntos/article/632/Visual%20Perception%20and%20Action%20in%20Sport.pdf

There is a fundamental misconception in the under script of the above *Figure 3.7*. The conception of the ball is okay but it has to be considered in relation to its ball trajectory and not with the *ball-glove relationship.* The relationship ball-ball trajectory has to do with the action trajectory of the Movement Action (MA). That is the only concern of the ventral and dorsal stream. The glove as a part of the actual catching has to do with the Motoric Movement(s) (MM). These Motoric Movements or technique are controlled in a proprioceptive way and not by the processing processes of the perception.
It is important to start realising that the action trajectory must be observed out of the perspective of the (movement) action object and that the technique (the movement trajectories) must be observed out of the perspective of the (movement) action subject (the person). The action trajectory and the movement trajectories have no relationship whatsoever. They belong to two different strictly separated worlds.

b. The Role of Internal Models and Prediction in Catching Balls[59]

"The present work provides further evidence of the existence of sophisticated internal models of the structure of the environment. We suggest that such models are used to predict upcoming events and plan movements in anticipation of those events."

"Conclusions
Retinal motion, stereo, and extra-retinal information from pursuit eye movements have all been implicated in catching balls (Oudejans et al, 1999; Rushton & Wann, 1999; Tresilian, 1999). We have demonstrated here that prediction is also important. This is consistent with Land & MacLeod's (2000) observations that prediction of the bounce point is important for intercepting the ball with the bat in cricket. In the present study, anticipatory saccades, head movements, and pursuit movements all reveal that acquisition of visual information is planned for a predicted state of the world. Such predictions must be based on a stored memory representation of some kind. The precision of the predictions reveals the quality of the information in the stored memory. The spatial and temporal precision of the anticipatory saccades, and the fine-tuning of these movements following a change in the ball's dynamic properties indicate that subjects have an accurate internal model of the ball's spatio-temporal path."

I don't have a lot to add to these passages. The last passage confirms everything. *The stored memory representation of some kind* is the perception of a shape of a ball trajectory. The trajectory connects the ball with a goal. Just like in tennis the incoming ball trajectory in cricket can be visualized from the same Initial Phase. The Initial Phase tells exactly where the ball globally will be after the bounce. The perception processes work from global to very precise along the progression of the ball trajectory. The *bounce point* is important but not more important than other points of the ball trajectory. Elite players in cricket know, *far* before the bounce point, precisely where the ball will globally hit the ground. Cricket players use the Initial Phase to determine from which area the ball will come up towards their bat. They also know that they can't spend more time on that task. They know that they need time for the saccade and the transformation from the reception to the sending task. There are two Motoric Movement Actions involved which must be combined. Once the first Motoric Movement Action gained sufficient information one can and must transition to the perception processes of the second Motoric Movement Action. The perception in the second Motoric Movement Action waits for the incoming ball trajectory to come to the perception of the intersection point of the two ball trajectories. The perception waits till it can give the signal to the body to strike. But even in the main phase of the

[59] M. Hayhoe, N. Mennie, B. Sullivan, & K. Gorgos; The Role of Internal Models and Prediction in Catching Ball; http://www.aaai.org/Papers/Symposia/Fall/2005/FS-05-05/FS05-05-011.pdf

swing a player will keep on receiving the ball till he hits the ball. So the first Motoric Movement Action is still going on when the second Motoric Movement Action is already in the main phase of the swing towards the ball.
From the perspective of the spectator it looks like a cricket player is actively looking at the bounce moment. That is not what is happening. His task is to produce an outgoing ball trajectory out of the incoming ball trajectory coming out of the bounce. From his cognitive basis a player considers a few intersection points of outgoing ball trajectories after the saccade. From the peripheral view he let the ball come to one of these points.
Batsmen in cricket mainly hit outgoing ball trajectories out of the 1st tempo of an incoming ball trajectory. The 1st tempo is the rising part of a ball trajectory after the bounce. This part combined with the high speed of the ball and the short distance of the pitch makes cricket batting a very difficult task. In tennis you can only compare this with a return on service against service specialists. Tennis players can learn a lot from cricket players concerning this game situation. Cricket players always face service specialists. They highlight the reception phase and mainly let the ball come towards them. Even in the main phase of the swing of the bat. They only make a little movement towards the ball to achieve a transfer of impulse. The speed of the ball works now in favor of the batter. This has to do with the dualism in ball trajectories[60].

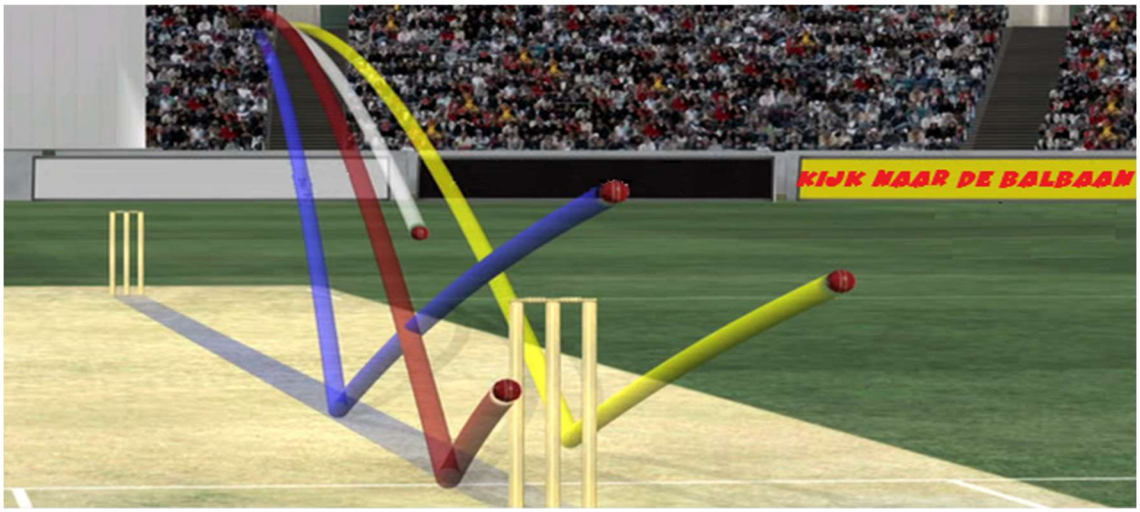


Image: During the Initial Phase of the incoming ball trajectory a batsman makes a precise perceptual image of the global zone where the ball will appear from after his eyes made a saccade. An elite player will use a little less than the white line to make that *prediction*.

If a player would continuously look at the ball he would have a great perception of the ball but he wouldn't be able to perform the combined catch and throw task. Then, like the *old Dutch stick catch game*[61], it will all become one big gamble.

c. The Visual Brain in Action[62]

"1. The Functions of Vision

[60] Chapter 10.5
[61] Chapter 5.2a
[62] A. David Milner, Melvyn A. Goodale; School of Psychology University of St Andrews Fife, KY16 9JU Scotland, U.K; http://www.theassc.org/files/assc/2367.pdf

Standard accounts of vision implicitly assume that the purpose of the visual system is to construct some sort of internal model of the world outside -- a kind of simulacrum of the real thing, which can then serve as the perceptual foundation for all visually derived thought and action.
--Of course, the visually guided behavior of many animals, particularly complex animals such as humans, is not rigidly bound to a set of visuomotor modules, however subtle those mechanisms might be. Much of our behavior is quite arbitrary with respect to sensory input and is clearly mediated by some sort of internal model of the world in which we live. In other words, representational systems have evolved -- systems that permit the brain to model the world, to identify objects and events, to attach meaning and significance to them, and to establish their causal relations. In humans and other primates, vision provides some of the most important inputs to these representational systems. Such systems are not linked directly to specific motor outputs but are linked instead to cognitive systems subserving memory, semantics, planning, and communication. Of course the ultimate function even of these higher-order systems has to be the production of adaptive behavior. The distinction between systems of this kind and the dedicated visuomotor modules described earlier is that the former enable us to select appropriate courses of action with respect to patterns of visual input, while the latter provide the immediate visual control required to execute those actions.
In our book The Visual Brain in Action, we argue that these two broad kinds of vision can be distinguished not only on functional grounds, but also by the fact that they are subserved by anatomically distinct substrates in the brain. Thus the distinction between vision for action and vision for perception helps us to understand the logic lying behind the organization of the visual pathways in the brain.---

2. The Visual Brain

Evolution has provided primates with a complex patchwork of visual areas occupying the posterior 50 % or so of the cerebral cortex (for review, see Zeki, 1993). But despite the complexity of the interconnections between these different areas, two broad 'streams' of projections have been identified in the macaque monkey brain, each originating from the primary visual area (V1): a ventral stream projecting eventually to the inferior temporal (IT) cortex, and a dorsal stream projecting to the posterior parietal (PP) cortex (Ungerleider & Mishkin, 1982).

In 1982, Ungerleider and Mishkin argued that the two streams of visual processing play different but complementary roles in the perception of incoming visual information. According to their original account, the ventral stream plays a critical role in the identification and recognition of objects, while the dorsal stream mediates the localization of those same objects. Some have referred to this distinction in visual processing as one between object vision and spatial vision -- 'what' versus 'where.'

Although the evidence available at the time fitted well with Ungerleider and Mishkin's proposal, recent findings from a broad range of studies in both humans and monkeys are more consistent with a distinction not between subdomains of perception, but between perception on the one hand and the guidance of action on the other.

3. Visual Awareness

According to the present interpretation, D.F.'s brain damage has uncovered a visual processing system (specifically the human dorsal stream) that can operate in relative isolation within the domains of size, shape and orientation. D.F. has no explicit awareness of the shapes and sizes that she is able to grasp by virtue of her remaining visual apparatus. We suggest that like D.F., we too carry out these functions using visual information that is not present in our awareness. Indeed, we suggest that in providing visual guidance for our actions the dorsal stream acts in large part alone and independent of any acquired 'knowledge base'.
We propose that the processing accomplished by the ventral stream both generates and is informed by stored abstract visual knowledge about objects and their spatial relationships. We further surmise that

the particular kinds of coding that are necessary to achieve these ends coincide with those that render the representations accessible to our awareness. This would fit with the idea that coded descriptions of enduring object properties, rather than transitory egocentric views, are precisely what we need for mental manipulations such as those required for the planning of action sequences and the mental rehearsal of alternative courses of action.

But of course, the mere fact that processing occurs in this generalized way in the ventral stream could not be a sufficient condition for its reaching visual awareness. For example, there are generally many items processed in parallel at any given time, most of which will be filtered out of awareness by the operation of selective attention.

4. The Visual Brain in Action

Although we have emphasized the separation of the dorsal and ventral streams, there are of course multiple connections between them, and indeed adaptive goal-directed behavior in humans and other primates must depend on a successful integration of their complementary contributions. Thus, the execution of a goal-directed action might depend on dedicated control systems in the dorsal stream, but the selection of appropriate goal objects and the action to be performed depends on the perceptual machinery of the ventral stream. One of the important questions that remains to be answered is how the two streams interact both with each other and with other brain regions in the production of purposive behavior.
At the level of visual processing, however, the visuomotor modules in the primate parietal lobe function quite independently from the occipitotemporal mechanisms generating perception-based knowledge of the world. Only this latter, perceptual, system can provide suitable raw materials for our thought processes to act upon. In contrast, the other is designed to guide actions purely in the 'here and now', and its products are consequently useless for later reference. To put it another way, it is only through knowledge gained via the ventral stream that we can exercise insight, hindsight and foresight about the visual world. The visuomotor system may be able to give us 'blindsight', but in doing so can offer no direct input to our mental life (Weiskrantz, 1997)."

The passages speak for themselves. It is completely in line with the Game Action. *"One of the important questions that remains to be answered is how the two streams interact both with each other and with other brain regions in the production of purposive behaviour"*. I give the answer with the Game Action. The perception processes towards the dorsal stream mainly see the ball. Relative to a ball trajectory. The action path. The perception processes towards the ventral stream mainly see the ball trajectory. Relative to the ball. The perception path. They are both active during the actual execution of a Motoric Movement Action in an ongoing mutual way.

d. Tussen de linies spelen[63]

"Tot aan de primaire visuele schors verloopt de verwerking van visuele informatie hetzelfde, maar daarna vindt de verwerking plaats via respectievelijk het ventrale en het dorsale systeem.

Het dorsale systeem, dat projecties van de primaire visuele cortex naar de posterieure pariëtale schors omvat, dient voor het oppikken van visuele informatie die gebruikt wordt voor de sturing van bewegingen. Dit systeem wordt ook wel 'vision for action' of kortweg het actiepad genoemd. Deze stroom van informatieverwerking betreft de (onbewuste) visuele sturing van bewegingen in de omgeving (actie), waarbij voorwerpen ten opzichte van de actor in een absolute metriek gecodeerd worden als egocentrische informatie.

[63] Prof.dr. G.J.P. Savelsbergh (2009); https://www.fsw.vu.nl/en/Images/Oratie%20Prof.%20Savelsbergh_tcm31-108263.pdf

Het ventrale visuele systeem, dat projecties vanuit de primaire visuele schors naar de inferotemporale schors omvat, betreft de (bewuste) waarneming van gebeurtenissen en voorwerpen in de omgeving (perceptie). Dit systeem wordt ook wel 'vision for perception' of kortweg het perceptiepad genoemd. In tegenstelling tot het dorsale systeem, kent het ventrale systeem alleen maar indirecte verbindingen met de premotorische schors, zoals via de ventraal prefrontale schors, die betrokken is bij geheugen-processen en het maken van beslissingen (Rossetti & Pisella, 2002)."

3. Perceptual organisation

There is also evidence out of the perceptual organisation. Several perception theories state that the conscious perception of an object is the result of *rough* perceptions getting organised to increasingly bigger meaningful units. Perception than is the reorganising of all lose elements our senses notice. Our perception fills blanks of lines. With invisible lines that is a lot harder. Maybe that is the reason why not everybody experiences these perceptions.

"*Perceptual organization*[64]

Everything we see, we see for the first time. While parts of a scene may correspond to objects we have some previous acquaintance with, we almost never see the same objects in the same configuration under the same lighting conditions from the same perspective.
Unless we can decompose a scene into coherent and independently recognizable entities, the complexity of natural scenes would render humantype vision impossible. How can we partition a scene into independent components without already knowing without what might be present? There are probably thousands of objects that can appear in an almost infinite variety of configurations and orientations that we can recognize, exhaustive matching against stored models is not a reasonable explanation of human perception.
It is largely agreed that there must be a set of generic criteria, applied independently of scene content that underlies the procedures discovered by nature for partitioning the visual field. Discontinuities in scene properties (distance, material composition, motion, etc.) are the most likely clues as to where partitioning or perceptual organization problem.
Psychologists have attempted to discover the laws underlying the partitioning decisions made by the human visual system. One of the earliest and intuitively most acceptable collections of such laws was proposed by Wertheimer in 1923 and elaborated by Koffka in 1935.

These Gestalt Laws of Perceptual Organization include:

- *The Law of Proximity: Stimulus elements that are closed together tend to be perceived as a group*
- *The Law of Similarity: Similar stimuli tend to be grouped, this tendency can even dominate grouping due to proximity*
- *The Law of Closure: Stimuli tend to be grouped into complete figures*
- *The Law of Good Continuation: Stimuli tend to be grouped as to minimize change or discontinuity*
- *The Law of Symmetry: Regions bound by by symmetrical boarders tend to be perceived as coherent figures*
- *The Law Simplicity: Ambiguous stimuli tend to be resolved in favor of the simplest"*

[64] https://www.siggraph.org/education/materials/HyperVis/vision/percorg.htm

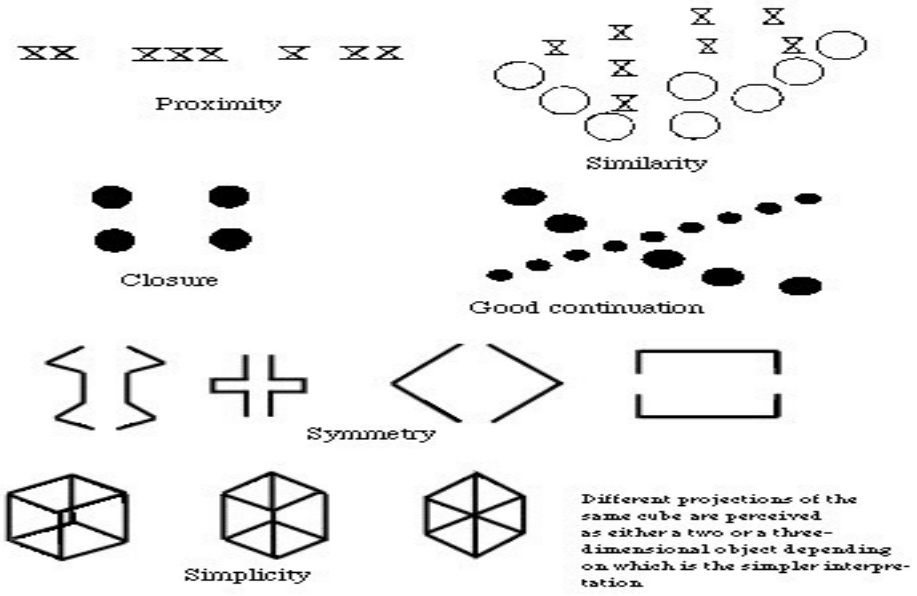


Image: The grouping principles of the perceptual organisation.

Feature detection.

A part of perceptual organisation is feature detection. If this option was not available in humans you would have to discover every object completely over and over again every time you are confronted with it.

"There are probably thousands of objects that can appear in an almost infinite variety of configurations and orientations that we can recognize, exhaustive matching against stored models is not a reasonable explanation of human perception."

It is assumed that humans develop templates. It is my proposition that in simple Motoric Movement Actions most people develop the same kind of templates but in more complex Motoric Movement Actions not everybody develops the same template.
This proposition can serve as an explanation for the difference in levels of tennis players. If you don't relate the place of a ball to a ball trajectory then there soon will be uncountable *template* possibilities. A ball trajectory diminishes these possibilities rigorously. Even better it will point to only one future template you have to reckon with.

4. The Tweener[65]

The tweener is the ball played between the legs. The tweener is the trick shot for boy talents between the age of 10-16 years. If you can't perform this shot you are *a loser*.

It is even performed at the highest levels during matches. Most pro's surrender once they make the decision to perform this shot. They know they lose the point and perform this shot to please themselves

[65] https://en.wikipedia.org/wiki/Tweener

and the crowd. Just a few players grab this opportunity to win the point. There are a lot of clips on YouTube[66] of Federer but also Nadal and Dimitrov. There are no women who perform the tweener in a structural way.
The tweener will arise mainly from a drop shot which just didn't succeed[67]. The opponent is able to just play the ball upwards in the last part of the 2nd tempo of a ball trajectory far below the net chord. The player who played the drop shot moved forward to a place around the service line. There he encounters an easy ball coming up which he can volley around shoulder height over the opponent who is now close to the net. The characteristic of that lob is that there is few ball speed involved, that the ball has a lot of potential energy because of the high contact point and that it relatively takes a long time to land in the court. If the ball speed exceeds a certain value in the x-axis[68] than the lobbed player will not be able to reach it in time. So the balls in ball trajectories which can be reached will drop down vertically in the last phase before the second bounce. The tweener is than actually hit in that last phase between the legs. The problem is not the shape of the ball trajectory or the ball trajectory defining factors (BTDF). The problem is to overrun the ball in a well-timed way.

Image: Federer hits *tweener*

If the tweener can be hit than it is an easy incoming ball trajectory. The disadvantage is that you only are able to create a flat outgoing ball trajectory. The advantage of this is that it is an easy ball to hit. The options for outgoing ball trajectories are limited to a flat lob or a flat passing shot. This last shot must contain a marginal angle of departure and a lot of ball speed. And you have the opponent at the net. The odds are against you in a very serious way. However the aforementioned players manage to succeed far more than one can expect if you look at the percentages. Especially Federer takes this game situation to another level. Not successful clips will not be presented on YouTube but if I saw him doing it live I only remember one occasion he didn't succeed. So the tweeners I saw succeeded for at least 90%. Of course every point is only one point but with this shot you give a real mental blow to the opponent as well.
In this paragraph I will appoint a tweener by Federer and mainly the Game Action in there[69]. I start at the moment when Roger recognises the game situation just after the lob has been played. His cognitive basis possesses all the possible action possibilities in this game situation. He knows when and where to execute all the actions. Even in a comfortable chair at home he can visualize all the ball trajectories

[66] https://www.youtube.com/results?search_query=tweener+tennis
[67] Chapter 10.11; Not completely perfect ball trajectories
[68] Chapter 10.1
[69] I use this video clip: https://www.youtube.com/watch?v=pMJ0-1GGf5k

and actions involved. In short you can say the cognitive basis will act as a blue print for this actual game situation.

Image 1: Tweener (picture 1, 2, and 3); *the main phase of the swing*

At first Roger must visualize if the lob can be smashed. From the Initial Phase of the incoming ball trajectory he will soon experience that a smash is not possible. The moment he realizes that he turns around and makes a first assessment of the shape of the incoming ball trajectory. There the Tactical Tennis Action makes the first global perception of an intersection point of an outgoing ball trajectory. This is more important here than in an usual stroke because the tweener must be hit at a certain height. There is not a lot of room to maneuver. At the same time Roger takes a gamble that his opponent will occupy an universal position at the net. Even Federer doesn't have eyes in the back of his head. At the professional level players don't retreat in this game situation. (What maybe would be better if they play against Roger). From the gathered information he decides whether to make a lob or to make a low passing shot and especially which direction he will give either one of them. This shot also limits the direction you can make.

The perception processes keep on following the ball trajectory and guide the perception from global to specific. The footwork is adjusted to this perception because he has to overrun the ball trajectory far in the 2nd tempo after the bounce. The easy part is that the incoming ball trajectory is pretty simple in that phase. The ball is coming down in a straight line without a lot of ball speed.
Like the Tactical Tennis Action explains Roger will have to progress from a global to a specific intersection point of the outgoing ball trajectory. He has to do that but is also able to do that because deviations of a ball trajectory will exponentially diminish the more of the ball trajectory is actually created.

If you look to the tweener clip once more you notice the following in this phase. He is running behind and towards the ball if the ball descends. He must keep the right distance and adjust his timing. When the ball is at shoulder height he comes closer and his eyes will make the saccade towards the intersection point of the outgoing ball trajectory. The eyes will remain there waiting and see the ball coming from there peripheral vision. When the ball is still a little above his knee the main phase of his racket swing starts. That is during or right after the saccade when there is no concrete vision. The perception again picks up its role very soon and checks if the latent ball trajectory, a really short distance now, will become the actual path of the ball. The ventral and dorsal stream take their roles again. Deviations will be adjusted by new perceptions and new checks in an ongoing mutual way. But if everything goes to plan real deviations will hardly occur.

Image 2: Tweener (picture 4, 5, and 6); *at the moment of hitting the ball (picture 4) Federer's head is always in the middle of the turn towards the net.*

When the ball descends to just under his knee Federer always starts turning his head. And if he hits the ball just above the height of his sock his head is always in the middle of that turn. The turn is completed way after he hit the ball. Actual perception with a turning head gives a lot of disturbed information. Federer doesn't look at the ball and I am convinced he doesn't use peripheral vision at the moment of hitting because of the movements of the head. This shows that he doesn't have to actually see the ball during the hit.
The Game Action says the same thing. He visualizes an intersection point and an outgoing ball trajectory from that point. He only needs actual information about the intersection point. The rest depends on perception processes in his mind and not on actual vision. The fact he scores so many points in this game situation can't be explained out of coincidence. He knows how to pass his opponent with the right ball trajectory.

"In tennis, maintaining the head on a vertical axis and keeping the upper body stabilised is recognised as one of the characteristics of high-level players (Elliot, 1989; Groppel, 1986). In particular, keeping the head still during the preparation phase and at impact helps insure better balance and a consistent hit on the center of the strings (Braden and Bruns, 1977; Saviano 2003)."[70]

So Lafont's conclusion isn't right in this game situation. At the moment Federer turns his head his upper body also starts to turn in a strange way. Of course there is a dynamic balance in Roger's movement but that is not meant with *stable upper body*. The head *and* the upper body are turning at the moment of the hit.

This game situation is also a blow for Joan Vickers. There is no gazing at any point. Not at the contact point and not at the goal. Nowhere. It is even worse. The head is actively turning and the results remain excellent. The Game Action explains it all. The incoming ball trajectory is easy and the technique asked is limited but quite easy to perform. Those are the easy parts of that game situation.

[70] Six Good Reasons to Keep Your Eye Off the Ball - Damien Lafont

When there is enough actual information the actual perception can better be transferred to the tactical outcome of the outgoing ball trajectory. Roger wants to know what consequences the perception of the already hit latent outgoing ball trajectory will have in this game situation. One game situation consists of two independent combined Motoric Movement Actions. A catch and a throwing task. The throwing task only needs an intersection point. The rest is perception.
The incoming ball trajectory in this game situation is quite easy. In other game situations Roger will prefer to maintain eye contact at more demanding incoming ball trajectories.

5. Federer serves with his eyes closed

The service follows the Game Action like all other strokes and the *tweener*, In comparison to The Quiet Eye the appointed Game Action will remain to be one consequent universal explanation of the reality of every Motoric Movement Action.
The service is also experiencing an incoming ball trajectory. In this case the player creates his own incoming ball trajectory. That makes the service from just being difficult a very difficult stroke. The incoming ball trajectory must be timed as well. A toss is never the same. In the long run a rhythm service will not work. Roger's serve must be timed as well and he executes all the actions which were described in the previous paragraph within the tweener.

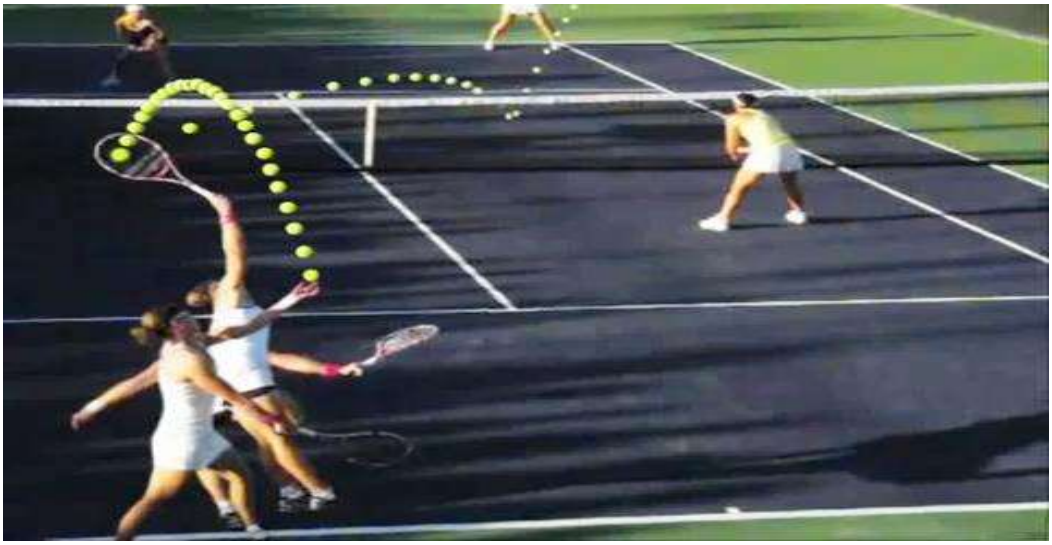


Image: The service is also experiencing an incoming ball trajectory

At American forums on the internet I was reminded that Federer sometimes serves with his eyes closed. That means that at moment of the actual hit his eyes are closed. There are several video clips which shows this quite clearly. From these clips I took two stills of the earliest moment of the closing of the eyes. The racket is in the main phase of the swing but still a significant distance from the contact point.
When Federer closes his eyes he gathered all the actual information he needs. From that moment he is only busy with the execution of the Initial Phase of the outgoing ball trajectory. The Initial Phase is the only possibility for him to influence an outgoing ball trajectory. He doesn't aim over the net. He doesn't aim at a goal area in the opponent's court. He doesn't gaze at the ball. He doesn't gaze at the opponent's court. His vision is at the inside of his head visualizing the intersection point of the two ball trajectories. That is the starting point of the outgoing ball trajectory. It is crucial to get the right angle of inclination from the racket towards the position of the ball. That angle is mainly determining the shape of the ball trajectory. Like in all game situations Federer must add a desired outcome of an

outgoing ball trajectory in the Initial Phase. Or with other words Roger hits the ball in the perception of the outgoing ball trajectory during the Initial Phase. This ball trajectory has been trained for many years. It contains the premises that automatically will take care that the outcome of that ball trajectory will be successful. There is no need for him anymore to have his eyes open because the shape of the incoming ball trajectory at that time is well known as well. From experience Roger knows exactly when the ball will be in the intersection point of the previous formed perception of the outgoing ball trajectory.

"Directing.
Many actions begin with a movement of the hand to contact an object. These are nearly always preceded by a fixation on the object (there were one or two cases where an object was contacted while the eyes were looking elsewhere; presumably this was done from memory). Typically only a single fixation is involved, and the eye usually moves away from the object just before the hand reaches it. Thus the grasp itself is often not executed under visual feedback.[71]"

Images: The first moment of closing the eyes; the racket head is still a significant distance from the intersection point.

By the way Federer doesn't hit all his serves with his eyes closed. He could do it because we can determine that he doesn't need them for actual perception during this last brief moment. Nadal is showing the same at the image below. The actual perception gathered enough information. The perceptual image doesn't need more input. The racket is in around the same position like in the images above.

[71] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities? http://ac.els-cdn.com/S004269890100102X/1-s2.0-S004269890100102X-main.pdf?_tid=f270a256-99c8-11e5-adbf-00000aab0f02&acdnat=1449152584_01e6d4abbe3f4f3cb29ef26d8717f6ec

Image: The first moment of taking away the eyes of the ball. Notice the similarities with Federer's pictures.

On YouTube there are several clips[72] of Michael Jordan performing free throws with his eyes closed. The execution follows the Game Action exactly like in Roger's serve. At the actual moment of shooting the ball you don't need actual perception anymore. However, because of the fact that a free throw only consists of the Motoric Movement Action *throwing,* a player can accompany the ball much longer during the Initial Phase. The Initial Phase in a free throw is approximately 0,5 meter. So there for the Initial Phase in a free throw could benefit more from actual perception.

6. Quotes

In interviews players have to answer lots of questions about their technique. The hitting technique is the eye-catching visible part of tennis and questions about it are logical. Ball trajectories are not visible. It would have been strange to ask players about that. First a funny researcher has to come up with that idea. I hope that this particular question will be asked in interviews in the near future and that it will become the main subject in scientific research.

Still there are a few hopeful quotes that elite players experience the game in ball trajectories.

"Top players seem to experience the game at a sub-verbal level. They use images and feelings to communicate information to their bodies, make split second decisions, and execute under pressure. They imagine what they want to do, and their tennis follows their imagination.
Once again, something McEnroe told me in 1984 gives an insight into how this actually happens. We were talking about how the Winning Edge video was designed to give players clear visual models of himself and Lendl. Suddenly John stopped and said something surprising--as if he were realizing it himself for the first time. "Sometimes I'll see the shot flash across my mind's eye just before I hit it!".

[72] https://www.youtube.com/watch?v=_JUjbpL9X7I

"I had the chance to interview Billie Jean King for my book and she told me that once she figured out she was doing this unconsciously, she ritualized it and used it methodically on virtually every point."[73]

"But a second problem of equal or possibly greater importance, is the issue of how teachers communicate information to players, and how this relates to the way most players actually learn. "I don't want to do this!" he said, "I'm out here thinking about things--what I'm doing with my right arm on my forehand-- and I don't want to think about stuff like that! I'm a 'no brain' player! " "I know we gotta do the basics man," he said, "but "I hate this!"

Luckily, after letting off a little steam, John applied himself to the task at hand, and ended up doing a great job in the basic sequences. In fact, he outplayed Lendl in the backcourt points we filmed. (It would be later that year that Ivan won his first Slam defeating McEnroe in the French final.)
In retrospect it makes an amusing story, but here was one of the greatest (and smartest) players of all time, saying that thinking about how he hit the ball was dangerous to his game!

And he isn't the only legendary player I've encountered who felt this way. I once asked Pete Sampras: "Pete, could you tell me a couple of things about how you hit your forehand?"
His response was, "I don't know." I said, "What do you mean you don't know? Can't you tell me one or two things about what you try to do out there?" His response, "I really can't explain it, it's just a natural feeling." Andre Agassi said almost exactly the same thing when I tried to ask him a technical question: "I never think about how I hit the ball."
Here are 3 players with about 30 Grand Slams between them, and none of them wants to think about or talk about how to hit the ball. And there are dozens of other similar anecdotes I could relate from my own experience or have heard from other coaches.
So if good players find verbal descriptions useless or counterproductive, what does that say about how most of us try to learn through traditional lessons? Don't we spend most of our time on the court trying to "understand" how to hit the ball? Can all that verbal information ever translate into actual strokes or shots?
Top players seem to experience the game at a sub-verbal level. They use images and feelings to communicate information to their bodies, make split second decisions, and execute under pressure. They imagine what they want to do, and their tennis follows their imagination."[74]

Chris Evert: "I was thinking of an important match last night. I visualised how that match was going to be and this helped me fall asleep. I had a court in my mind and I could see every point. I played the points in my mind exactly the way I wanted them to be the next day".[75]

All quotes are in line with the Game Idea. Elite players play a *game*. They make chains and prevent the opponent from doing that. That is what it's all about. How you execute the stroke, *friendly* (mental) *eyes*, looking at an abstract ball etc. all don't belong to the *game* of tennis. Instructions concerning those matters all address Self-1 and must be rejected. Self-2 will only be addressed if a player executes only those tasks which the Game Action demands. Then and then only flow and playing in the zone will occur.

7. Feeding a 45° round ball trajectory

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[73] John Yandell; Visual Tennis; ISBN 13: 9780385264228
[74] John Yandell; Visual Tennis; ISBN 13: 9780385264228
[75] Tennis is a Mental Game - Part one; Dietmar Samulski; Coaching & Sport Science Review Issue 40, December 2006

You may ask yourself if you see the game in ball trajectories. Maybe you don't recognize it as such. However within each of you your bodies incorporated at least parts of the Game Action. I am assuming now that if you read this you have hit a ball for a few years.

A clear example is when I feed you a 45° round ball trajectory from a close distance. You recognize the shape of the ball trajectory at once and you know before the bounce how it will rise after the bounce. You know as well that you just have to wait for the ball to come to you (beginners step in!). You wait until the ball crossed the highest point after the bounce and is coming down. There (in the 2nd tempo) you hit it easily with and *under and over* technique. I can even ask you with such an easy incoming ball trajectory to deliver several outgoing ball trajectories. You have incorporated the perception and the hitting technique completely.
Now look at the court with a teacher and a complete beginner. The teacher thinks he feeds a simple ball. Though the beginner experiences the biggest problems. First the distance is short. There is not a lot of time to react. Second it is the most difficult ball trajectory out of the standard ball trajectories. It is a 45° round ball trajectory. It has the greatest y-axis factor[76]. From the usual ball trajectories this shape of the ball trajectory is the hardest ball trajectory to receive and the hardest to hit. Beginners with still flattish strokes now really have only one point where they can make an intersection point. The teacher would do better if he increases the distance and feeds a flatter incoming ball trajectory.

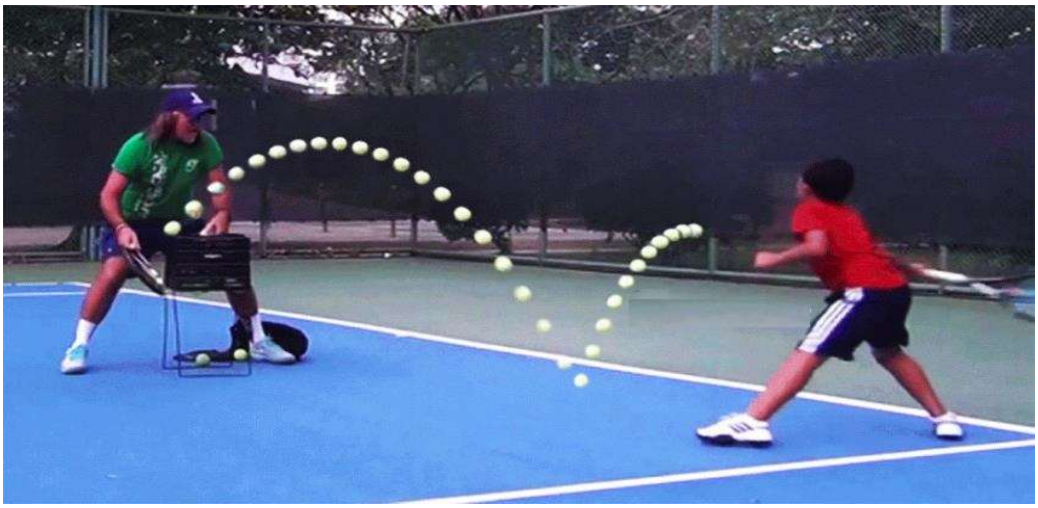


Image: 45° round ball trajectory

That you are not aware of automatic adaptations of your body proves scientific research when you pick up a glass. Pressure of the hand and function differ significantly if we either pick up an empty glass, a full glass or a turned glass. Your body automatically adapts the pressure of the hand muscles and the opening of the hand to the perception you made of the situation. In terms of the Game Action your body makes a different tactical plan for each of the three situations out of the cognitive basis.

8. Empiric experience

I am a scientist and did research and developed methods in dance. Part of that was participating anthropological research in different dance cultures. That demands an objectivised view on the matter. I did the same in tennis education. Unfortunately I was only able to do that for a short period. After my tennis graduation I worked for two years at tennis school Buitenveldert and right after that period one

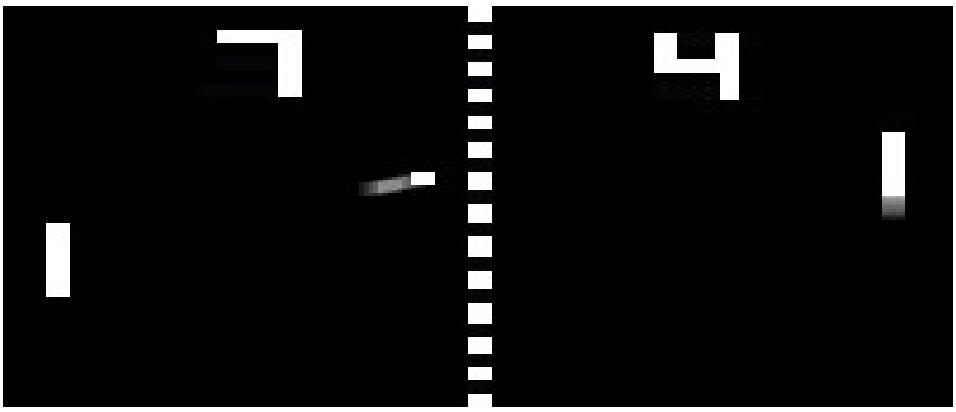
[76] Chapter 10.1

year at TV De Algemene/IJsbaanpad. That is now four years ago. Due to personal circumstances I was not able to teach in a structural way. Till now I just taught two hours a week at TV Smashing Pink. Only during summer.
From the beginning I taught ball trajectories. However the model wasn't completely finished. So I only have trained parts of the model with students. Even so there are results worth mentioning. Among a lot of individuals, I trained and coached four competition teams at Buitenveldert for one summer and winter. At De Algemene/IJsbaanpad I trained and coached two competition teams. All six teams became champion the next competition.
Within all my students the average rising of their ranking was 0,5 point in one year. Around 15% kept the same level. Even after two years. Nobody got worse. Besides that there are a few amazing results. Around ten people raised more than 1.0 point in one year. Three of them raised on average 2.0 points. Unfortunately I was never able to ask them how they have incorporated the ball trajectory instruction till now.

I only know how I see it myself. I started with the thick yellow lines one can see in televised tennis matches. Now that I am completely able to think in ball trajectories there are no thick yellow lines anymore. Those disappeared rather quickly. I now possess an image library of reference ball trajectories in my cognitive basis. Every time a new incoming ball trajectory is coming to me I relate the actual ball trajectory to this library. My cognitive basis knows from every incoming ball trajectory the key points of possible connections with the outgoing ball trajectory. I have incorporated it at such a level that I always relate a ball to a place where it is soon going to be. Actually I don't see ball trajectories anymore. For me they have become very clear invisible lines.
Because of my age and researching attitude I gave the privilege to explain the game which I now finalize with this book and to explain the different technique models[77] which I found in every stroke. No time remained to work on my own ranking but I can say that I improved a few levels because of all the new insights.

9. Pong

This part has been written only for those readers who once played Pong. Pong is a computer game made in 1972. The object in Pong is to not let a white dot pass *your* white stripe. It will make you lose a point. It was sold as a tennis game. The game needed two players.



[77] Chapter 13.3

The first question is: "Were you a good Pong player or not?" The second question is did you see the dot as just a dot or did you visualize, out of the Initial Phase of the manifest line, the latent part of it? If you were a good Pong player this was the likely thing you did.

Chapter 5 – The Motoric Movement Action

1. The Motoric Movement Action
2. Catching and throwing
3. The Motoric Movement Action and succes rates

This chapter is written as an extension of the previous one. Evidence becomes stronger if essences from the Game Action in tennis can be applied to all motoric movements we make. It proves that the complex system model is universal for all Motoric Movement Actions and in no way gets damaged. Besides that it is the illustration for the next two chapters concerning the specific Motoric Movement Actions in tennis.
In my book about the Motoric Movement Action[78] I will expand more on the Motoric Movement Action in general. In this book I solely work towards the Motoric Movement Actions in tennis.
The general formula for the Motoric Movement Action is MMA = MM x (MA). Because in this book it is about sports/games I further specified the parts. The explanation of the Motoric Movement Action (MMA) now becomes the explanation of the game (GBA). The Motoric Movements in tennis we call technique (Te) and the Movement Action (MA) can be renamed more specific into Game Action (GA). The formula then becomes GBA = Te x (GA). But substantially both formulas comprise exactly the same.
The name Motoric Movement Action has been chosen linguistically to be able to specify every Motoric Movement Action more towards the action involved. The posting of a letter can be appointed as the Motoric *Post* Action with the Tactical *Post* Action and the Actual *Post* Action as components. Like we can specify the technique (in tennis) as *tennis* technique we can also appoint the Motoric Movements (in posting) as *post* technique.

1. The Motoric Movement Action

Every conscious movement we make as humans can be appointed as Motoric Movement Action.
Every Motoric Movement Action possesses only two, completely separated, parts. The Motoric Movement (MM) and the Movement Action (MA). The explanation of the Motoric Movement only appoints the execution of the Movement Action. Although I add new insights in that part as well, the full explanation of the Movement Action (Game Action) contains the most revolutionary steps. In this book I will mainly appoint the Movement Action. The technique (Motoric Movement) is only appointed in a compressed way[79].
The Movement Action only contains the explanation of the processes the action demands. In tennis the Movement Action (in sports renamed as Game Action) is only concerned with the explanation of the

[78] Caught In A Line ~ *The Motoric Movement Action*; N.J. Mol – November 2016
[79] Chapter 13 - Technique – An introduction to *The Inner System*

game and not the playing of the game. The explanation of the game in tennis is from the perspective of the ball. Only the place of the ball is defining the game. In posting a letter the Movement Action must be appointed out of the perspective of the letter. The Movement Action in that posting task describes the compelling processes which the task imposes out of the *object*. The Motoric Movement describes the compelling processes which the Movement Action imposes out of the *subject*. My explanation will have the consequence that you will never be able to post a letter again. From now on the letter will post itself. We can only execute this *Post* Action.
This kind of reasoning is not to come up with just a nice academical story. These facts are very important because our perception processes see it that way. This is how we perceive Motoric Movement Actions.

Every Motoric Movement Action has its origin in a cognitive basis and if we are really going to execute an action it has a tactical and an actual action component. Perception processes play a crucial and dominant part. In the professional journals there are many known sorts of perception processes[80].

"The eyes usually reached the next object in the sequence before any sign of manipulative action, indicating that eye movements are planned into the motor pattern and lead each action.[81]"

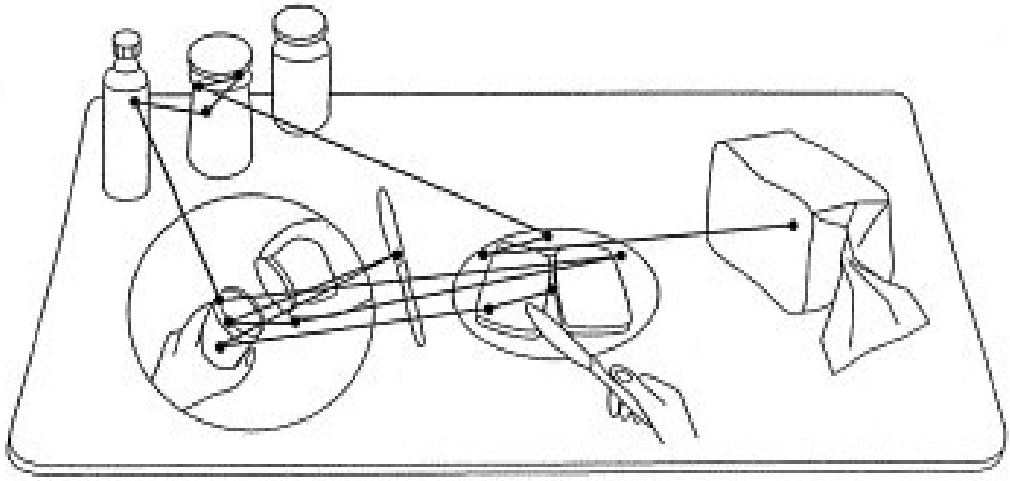


Image: Latent action trajectories in a bread preparing task

The tactical component is concerned about the *how* of the execution. On the basis of general cognitive reference images and the familiarity with the cognitive abstraction of the task at hand one action trajectory will be chosen out of a bunch of possible trajectories when the task is really executed. A choice for one tactical approach will determine one action trajectory. Only one trajectory can be made in one Motoric Movement Action. The perception processes while making a tactical plan compare the actual situation with the stored cognitive reference images of tactical action trajectories.

The actual component considers this choice for one trajectory as the only existing possibility. During the actual execution many perception processes are active. There is no need to appoint them all. The important thing is how all these perceptions are processed in mainly two streams. The ventral stream and the dorsal stream.

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[80] https://en.wikipedia.org/wiki/Perception
[81] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities? http://ac.els-cdn.com/S004269890100102X/1-s2.0-S004269890100102X-main.pdf?_tid=f270a256-99c8-11e5-adbf-00000aab0f02&acdnat=1449152584_01e6d4abbe3f4f3cb29ef26d8717f6ec

On the basis of the tactical action the ventral stream continually tries to make images of the latent parts of the action trajectory. For that purpose she uses the Initial Phase of the object trajectory and the already manifest part of the object trajectory. The ventral stream tries to imaginary lengthen the action trajectory. It does see the object but the shape of the trajectory is dominant.
The dorsal stream focusses mainly on the object although the object trajectory is also noticed. The actual place of the object is leading the actual motoric movements.

These streams[82] have an ongoing mutual relationship. The perception of the latent trajectory leads the actual place of the object. The actual place updates the perception of the latent part. If the object follows the perception according to the plan it keeps the previous image. It will adjust the perception if the object deviates from its path.

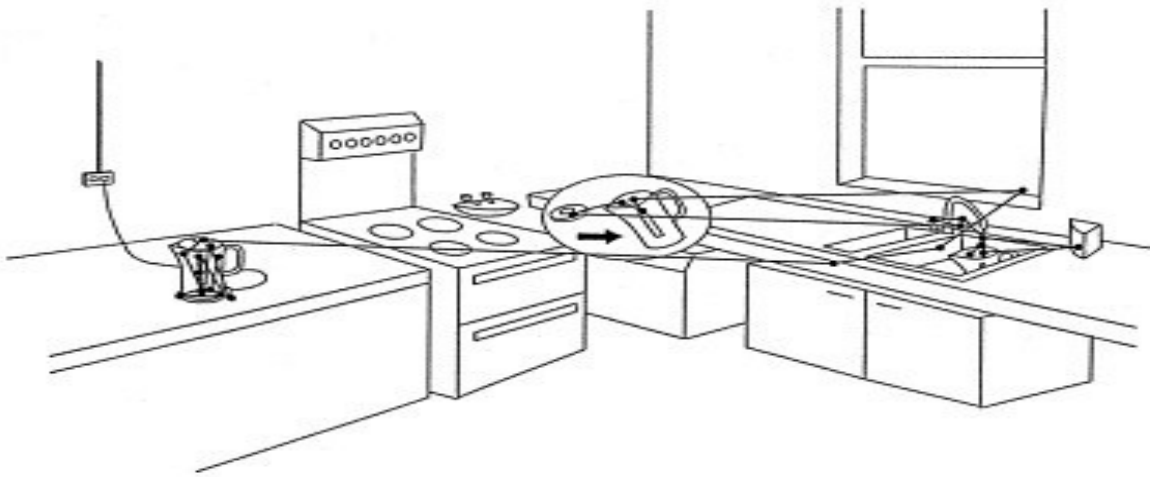

Image: Latent action trajectories in a tea making task

In the next scheme I will appoint the mutual relationship in a few well-known Motoric Movement Actions.

Motoric Movement Action	Ventral stream processes	Dorsal stream processes
Writing	The whole letter; (with in it a point of a pen)	The point of the pen; (in a letter)
Posting a letter	The action trajectory from the letter to the slit; (with a letter in it)	The letter; (in the action trajectory)
To open the front door with a key	The action trajectory out of the perspective of the key to the lock; (with a key in it)	The key; (in the action trajectory)
Free diving	The trajectory of the diver; (with the diver inside)	The diver; (in the action trajectory)
Tennis	The ball trajectory; (containing the ball)	The ball; (as part of the ball trajectory)

[82] Chapter 4.2

2. Catch and throw actions

Motoric Movement Actions can be divided in two categories. On the one hand the actions where you can keep on holding the object and are able to guide the action trajectory constantly and on the other hand the actions you can't do that. This last category is the domain of the catch and throw actions within the Motoric Movement Actions. They are also relevant in tennis. Tennis combines two separate Motoric Movement Actions which in principle don't have any relationship with each other. Out of the catching an immediate throw must be created. That is why it looks like one task. This has confused the spectators in general and almost all researchers till now. From now on people should treat the binding of two ball trajectories as two separate Motoric Movement Actions which must be glued together.

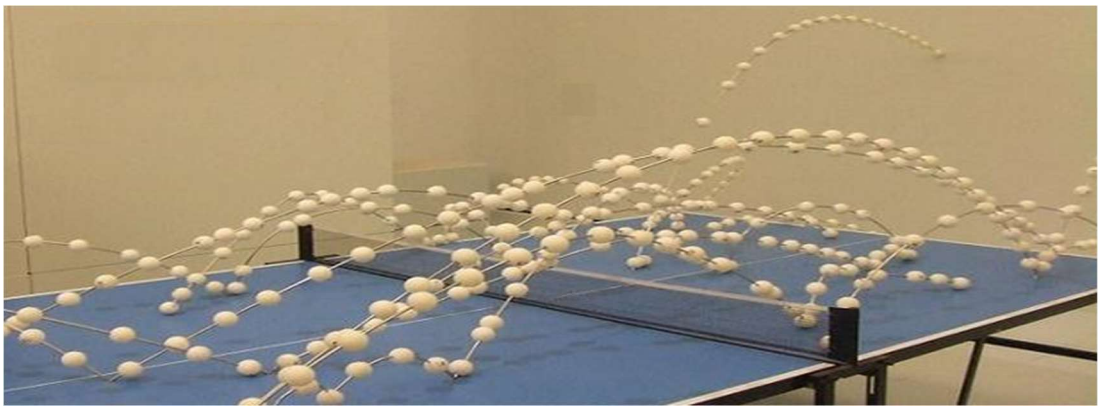

Image: Tennis can best be compared with table tennis.

There hardly exist combined catch and throw actions in daily live. And even in sports the catch and throw process in tennis has a special spot. Compared to hitting sports tennis is different because it requires more cycles in a chain of ball trajectories. Compared to team sports tennis is different because of the strict conditions ball trajectories require. In team sports, except for volleyball, the ball can bounce unlimited times and everywhere. In tennis a ball trajectory has to cross a net. It is obligatory to move the ball horizontally. Sports with more resemblance to tennis are volleyball, table tennis and badminton. In volleyball you are allowed to play the ball several times and they share the characteristic of badminton that the range of ball trajectories in these sports are limited. Tennis as a catch and throw process can best be compared with table tennis.

a. The Motoric Movement Action *Catching*

I appoint in here the basic catch action with the hand. We can catch with several body parts and with a lot of attributes but that all follows the process of catching with the hand.

In catching we use general cognitive knowledge we have buffered in life. People with a lot of catching experience have all kinds of references of catching actions in their memory. They know how an object behaves ballistic wise. Besides that there is abstract knowledge about the task. Something flies through the air and we have to be there where the object trajectory is coming down. This all contributes to a perceptual tactical basis.
If we are really going to catch that basis is completed with actual information about the location. Which object must be caught? What is the distance? Which object trajectory will approach us. That all contributes to the shaping of a precise image of what will globally approach us. That image not only

guides the upcoming catching action but also limits the uncountable latent possibilities of a general throwing action drastically. Although the picture is much more limited because of this tactical movement action still a considerable amount of perceptions of latent incoming object trajectories are considered from the throw area.
If the object is actually thrown than the blueprint of the tactical movement action is quickly placed as a frame work upon the actual situation. The actual movement action is forced to make images of the incoming object trajectory from global to precise. There for it uses the Initial Phase and the manifest parts of the object trajectory. There are a lot of perception processes involved.

"There is much more to perfect vision than having normal eyesight. While the term "sight" emphasizes the clarity of image on the retina, vision encompasses a broader meaning as the mental process of deriving meaning from what is seen and is the output of visual pathway integrity, visual efficiency and visual information processing.

Although, the eyesight plays a critical role in image formation in the retina of the two eyes, the complex process comprising of the relay of the ball efficiently. A set of visual skills are required not only for the batsman but also for all of those trying to catch the ball. For instance, the ability to catch a ball requires continuous convergence of the eyes, assessing the speed of the ball and predicting its path [7]. To actually catch a ball, one must combine the eye's inputs with activation of the body's motor system to get the hands in the correct place. This complex process requires a set of visual-motor skills in the form of depth perception, saccades and pursuits, eye hand coordination, vergence, peripheral awareness and visual reaction time.[83]"

Image: A *catcher* (baseball) makes a perceptual image of the latent part of a ball trajectory out of the manifest part. Obviously the ball is not coming towards him[84]. The catcher first has to move his glove with a running action to the now globally assumed end of the ball trajectory.

[83] Impact of Visual Skills Training on Sports Performance: Current and Future Perspectives; S. Khanal; http://medcraveonline.com/AOVS/AOVS-02-00032.pdf
[84] Chapter 10.10

I limit myself to the processing processes of the perception. The dorsal stream and the ventral stream. The ventral stream tries to make predictions about the latent part of the object trajectory from the tactical movement action, the Initial Phase of the object trajectory and the actual manifest parts of the object trajectory. The ventral stream observes the object but the shape of the trajectory is dominant.

The dorsal stream is mainly observing the object. It sees the object trajectory but the object is dominant. It's concerned with actual locations of the object and the actual motoric movements linked to these places.
The two systems have a mutual ongoing relationship till the task is completed. With every unit of time the ventral stream provides a new possible end of an object trajectory and the dorsal stream checks for deviations of that trajectory. Deviations will give a new perceptual image which will be checked again etc..

In the beginning the image of the end of a trajectory is allowed to be global. A precise prediction is not possible at that time but it is also not necessary. Though it is very important to create a precise global image. In that phase the object still has to travel for a relative long time. The chance of deviations decrease exponentially with every next time unit.

When the object comes closer a catch position must be appointed. The best catch position is a position sideways of the incoming object trajectory. The shape of the trajectory can best be observed from there (volley). In the last phase of an incoming object trajectory the hand will be raised in a general position where most perceptions of the end of the latent object trajectories end. The hand stays in a position where it can be actually observed. The focus is still mainly on the perception processes of the trajectory. So we see our hand with our peripheral vision with the main image of the object trajectory.

Only till the object is really close (within one meter) we transition from receiving the object trajectory to the actual catching. At that time it is possible to do that. Now the object trajectory is almost completely manifest. The chance of deviations is limited to a minimum. The perceptual, still latent, end of the trajectory needs less attention of the dorsal and ventral stream. Although they will continue to perform their tasks the emphasis will now transition to the actual catching of the object.

The perception processes clearly change focus at this moment. The final task is the catching part. The eyes make a saccade. In the earliest phase after the saccade the perception focuses again on the processing processes but now the object trajectory is in peripheral vision and the hand is in the actual image. Now there is only a really short piece of latent trajectory left. The ventral and dorsal stream will still mutually influence each other till the object almost reaches the hand. The dorsal stream already activated gross motoric movements of the body and is now fine tuning the actions needed. At the moment of actual catching the hand opening and the muscle tension are completely adjusted to the incoming object. The shape of the object determines the shape of the hand.

"Zoals ik zo juist beweerde is een correcte perceptie onlosmakelijk verbonden met een succesvolle bewegingsuitvoering. Dit wordt geïllustreerd in het volgende filmpje. Zoals u ziet, pakt de jongedame het glas probleemloos op – een eenvoudige dagelijkse beweging die een samenspel vereist van het benutten van visuele informatie en het genereren van de juiste krachten in arm en vingers. Veranderen we de visuele input, bijvoorbeeld door het glas te vullen met water, dan zien we dat de beweging naar het glas en het optillen daarvan iets langer duurt. Het volle glas vereist dat het glas behoedzamer gemanipuleerd wordt, terwijl de kracht van de vingers groter moet zijn vanwege de hogere massa. Wanneer het glas ondersteboven staat, wordt het zo opgepakt dat het meteen kan worden gebruikt (Rosenbaum

e.a., 1992). Straks na afloop bij de receptie mag u dit zelf uitproberen, mits u eerst uw glas heeft leeggedronken.[85]*"*

After the saccade the perception just kept sight on a little zone where the incoming trajectory could emerge from. In the beginning of the trajectory it considered many more incoming trajectories. The perception processes work from global to very refined. So now there are only a few incoming trajectories left. The hand takes account of just very little deviations and is now in a position where most of those trajectories will find their perceptual end. So from that position the hand only needs to perform a little adaptation. For the greatest consistency the hand must stay in the global position and mainly let the object come to the hand. This last sentence contains the key to elite catching. Until the moment you really feel the object touching your hand you are receiving the object. Till that moment you must let come the object to the hand. This essence is never acknowledged in tennis.
The greatest mistake in teaching tennis is the mantra: "Watch the ball!". The main subject of this book. But in second place another mantra: "Go to the ball!" has been the wrong and detrimental line coaches used. That means that sometimes you have to make a sprint towards the ball but then you also have to let the ball come to the imagined intersection point. It is the essence of catching.

A magnification of this last perception phase one can find in the antique Dutch *stick catch* game. The eyes must be fixed on all hanging sticks. The peripheral vision is mainly at work during this task. All sticks make latent action trajectories within the perception of the catcher. In this case they make square vertical lines with the ground. With the cognitive basis for this task as starting point all catching places can be visualized globally. The hand is configured to catch a stick. Hand opening, muscle tension etc. are configured *automatically* on the basis of tactical reference images.

Image: Antique Dutch *stick catch* game

[85] G. Savelsbergh; Tussen de linies spelen; http://www.fsw.vu.nl/en/Images/Oratie_Prof._Savelsbergh_tcm250-108263.pdf

Then if one stick actually falls this peripheral vision changes with a quick saccade to the possible expected catch zone of one of the latent action trajectories which becomes manifest now. The perception processes guide the hand to a place where the chance of a catch will be optimised. The difficulty of this game is situated in the fact that only at the last moment there can be made a precise prediction of the global end of the action trajectory. The hand can't gradually be directed by continuous confirmation of perception information like in normal catching. In this situation the hand is most of the time forced to make a movement towards the stick because it is not in the right zone. The catching gets more difficult because the action trajectory of the stick and the motoric movement trajectory of the hand make a square angle. Like in normal catching the greatest chance of catching will occur if the catcher let the stick come to the hand. Even though the hand will have to move.

In daily live we don't catch a lot. It happens when we or somebody is pouring a drink and we have to catch it into our glass. That is a simple catch action. More difficult catch actions only exist in sports. So sports can't rely a lot on references out of daily live.

b. The Motoric Movement Action *Throwing*

In throwing we use general cognitive knowledge we have buffered in life. People with a lot of throwing experience have all kinds of references of throwing actions in their memory. They know how an object behaves ballistic wise. Besides that there is abstract knowledge about the task. We know we have to throw an object into a trajectory where we can only influence the beginning of that trajectory. During that Initial Phase the end of that trajectory must already be shaped. This all contributes to a perceptual tactical basis. This is what we can do at home sitting in a comfortable chair.

If we transfer to an actual throwing occasion this tactical basis is completed with information about the location. Which object must be thrown? Over what distance? Which object trajectory will reach the goal destination? That all will complete the Tactical Throwing Action. Finally it has to come up with one precise prediction of an action trajectory which will reach the goal and reduce that to an Initial Phase. The Initial Phase must contain the conditions for the perceptual end of the trajectory to arise *out of the blue*.

The Actual Throwing Action considers this Initial Phase of this specific trajectory as the only existing trajectory in the world and just starts to execute this Initial Phase. During the Initial Phase a pitcher throws the object into its object trajectory and can't control it anymore after this phase.

The Initial Phase in just a throwing task is relatively long. One can visually guide an object for quite an amount of time. Now the ventral stream and the dorsal stream accompany the trajectory of the Initial Phase. The Tactical Throwing Action has made a perception of the shape of the Initial Phase. This now becomes the guide for the actual place of the object. Deviations of the perceptual object trajectory will be adjusted in an ongoing mutual perception process.

When the Initial Phase of the Actual Throwing Action is completed actual vision has little more function. It can only give guidance to expectations we can have towards the object reaching its goal while the object is still in flight. We can compare the actual trajectory with the perceptual trajectory. Maybe we want something with throwing actions but we can't control the end of a trajectory when the object is at the end. So actual perception processes stay more pregnant in catching actions than in throwing actions. Actually processing the outcome of the Initial Phase is very important when we have to create feedback when we get second chances to perform the same throwing task again. The feedback will enrich the cognitive basis in a short period of time and so the next tactical throwing action can take that new information into consideration by adjusting the Initial Phase.

So in a throwing action the perceptual shape of the object trajectory gives maximal support to the realization of the shape of the Initial Phase. The crucial point is the point where the object is released and starts to make its trajectory on its own.

"The locations of the fixations were also very reproducible between subjects, for example, subjects fixate the mouth of the bottle when pouring and then transfer gaze to the level of cola in the glass when about half-way through. Thus many details of the fixations, and by inference the ongoing visual computations, are governed by the task goals, together with the physical constraints of the world.' (Hayhoe, 2000). It seems that the way the human visual system is constructed ensures that competent subjects acquire very similar oculomotor techniques when they interact with objects.[86]*"*

In daily live we know several throwing actions. There is a lot of *throwing* with fluids if we pour drinks or if we empty a package into a cooking pan. We also pour if we open a water tap. Also think about the number one message in the smallest room of the house. Even a letter posting task contains a very small throwing action in the last phase. The Initial Phase of that throw is manipulated maximally due to the fact that the shape of the letter is already parallel stuck into the slit of the mailbox. In that task there is no specific goal the letter must reach. The execution of the Initial Phase will provide a 100% success rate.

In all those tasks the beginning of the object trajectory and the perceptual shaped latent object trajectory are essential parts of the perception processes. These parts will induce the most important conclusions in the Game Action in tennis. In a sending/throwing task we only need a perceptual perception of the outgoing ball trajectory. Because the tennis court always stays the same we only need actual perception in creating an intersection point of the two curves and we need actual vision of the Initial Phase. That is all. There is no need to hit over the net and there is no need to look at a goal area in the opponent's court. In fact those actions feed Self-1. It withholds a player from the real tasks at hand and must be rejected.

The perception only needs to find an intersection point and to visualize an outgoing ball trajectory from there out of the Tactical Tennis Action. The Actual Tennis Action needs to allow the ball to come to that intersection point and to execute the Initial Phase of the outgoing ball trajectory at that spot. The ball trajectory comes into existence completely at the side of the player and nowhere else. One of the many conclusions which can be derived from this is that consistency in a service must be trained at the baseline where the player is standing[87]. Consistency is only due to the consistent construction of the Initial Phase. If the first part of the ball trajectory is made correctly the service will cross the net and will go into the service box.

After the actual hit the perception will have to transition to the tactical outcome of the outgoing ball trajectory. The actual perception must check how the actual ball trajectory differs from the perceptual ball trajectory which was the guide for this task. Any deviations in that image might have consequences for the Tactical Tennis Action.

3. The Motoric Movement Action and success rates

[86] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities?
[87] Chapter 12

With most daily live Motoric Movement Actions we don't think in success rates. Most of them succeed in one time. However there are Motoric Movement Actions who don't succeed in one time or succeed just partially. Think about blowing out the candles on a birthday cake. To put a thread into a needle. To hit a nail with a hammer. To pour fluids into a glass. The number one message in the smallest room of the house. For a lot of men it is a lifetime struggle to deliver all the fluids a 100%. But also think about parking a car backwards. Every Motoric Movement Action actually has a success rate. The success rate is 100% if an action always succeeds in one time.

The success rate will diminish if an opponent decides to prevent us from blowing all the candles or continuously would pull our arm if we wanted to get a thread into a needle. A penalty kick can be executed perfectly but a goal keeper can just have anticipated to that perfect trajectory. If we had to throw a letter into a mailbox from a distance of one meter than the success rate would be very low. That is why we arrange daily Motoric Movement Actions in such a way that they succeed almost every time.

Catching and throwing actions will not have a 100% success rate. Sports in general will not have 100% success rates. Then there is no challenge and the sport will not be a sport. In ball games with a small ball and high ball speeds and where an opponent is keeping you from succeeding there will be a definite decrease of the success rate.

In tennis that is the case as well. All strokes in all game situations have universal success rates. I will appoint a few principles which have an influence on these rates.
The closer you are to the net the ball trajectory will have a higher success rate. The more ball speed an incoming ball trajectory possesses the lower the success rate of creating an outgoing ball trajectory. A cross-court ball trajectory has a much higher success rate than a long line ball trajectory. In cross-court ball trajectories it doesn't matter if the ball deviates left or right from the desired ball trajectory. In a long line ball trajectory that deviation could make a big difference. Round ball trajectories have higher success rates than straight ball trajectories.
It is important to notice that Game Intentions, shapes of ball trajectories and percentages have a definite correlation and a set relationship.

As an extra example I will appoint the *shot-to-nothing*. If a player is forced into a game situation where he not will be able to return to a good defending position of his court after he hit the ball it doesn't make sense to play a *normal* rally ball. The opponent will finish that ball easily in the open court. Than the success rate will become 100% but not for the player. When that occurs it is better to create a shot with the aim to score at once. The player has to produce a ball trajectory with such ball trajectory defining factors (BTDF) that the opponent can't make a valid ball trajectory out of it. The shape of the ball trajectory must be flattened and the ball speed must be high. A player is doing well if he scores 1-3 points out of ten. If he doesn't do that the percentage will be practically zero. Also in here a player has to learn to optimise percentages.

Players need to know which percentages belongs universally to every stroke in each game situation. The universal phase of knowing these percentages must be followed with first the phase of player specific percentages and second the phase of opponent specific percentages. This knowledge must be part of the cognitive base which is mandatory for an elite player. The cognitive basis shapes the template for the Tactical Tennis Action.

Chapter 6 – The Tactical Tennis Action

1. Introduction

The Game Idea in tennis entrusts players to make chains of ball trajectories and at the same time to prevent the opponent to fulfil that same task. The Actual Tennis Action is only concerned about the first part. The connection of ball trajectories to chains. The *old* tennis action is only concerned about the second part.

These tasks are two completely different processes but they take place at the same time. The Actual Tennis Action must connect one specific incoming ball trajectory with one specific outgoing ball trajectory. The ball trajectories are just considered as the only existing curves and these lines must be connected. The Tactical Tennis Action also looks at an incoming ball trajectory and an outgoing ball trajectory but she doesn't see them as just lines. She must judge the lines for their intrinsic tactical value. There are many perception processes involved. They feed both actions at the same time till the chain stops. It is a continuous process and comprises more than one cycle of a chain. The perception processes continuously make future images and check these images with the reality.

The Tactical Tennis Action must and can deliver only one outgoing ball trajectory out of the many options to the Actual Tennis Action. That is the ultimate task of the Tactical Tennis Action. The Actual Tennis Action will only allow one choice. Every Motoric Movement Action only allows one action trajectory in one action. Even if you decide to do the half of one trajectory and the half of another trajectory the outcome will be only one action trajectory. It is a basic principle. From that perspective one can say that the Tactical Tennis Action serves the Actual Tennis Action.

The Tactical Tennis Action follows the tactics like in every Motoric Movement Action. She has a cognitive basis which can be visualized at home while sitting in a chair. The cognitive base contains specific images of the *how* and *why* of the task and also abstractions of the task.

"Standard accounts of vision implicitly assume that the purpose of the visual system is to construct some sort of internal model of the world outside -- a kind of simulacrum of the real thing, which can then serve as the perceptual foundation for all visually derived thought and action.

Of course, the visually guided behaviour of many animals, particularly complex animals such as humans, is not rigidly bound to a set of visuomotor modules, however subtle those mechanisms might be. Much of our behaviour is quite arbitrary with respect to sensory input and is clearly mediated by some sort of internal model of the world in which we live. In other words, representational systems have evolved systems that permit the brain to model the world, to identify objects and events, to attach meaning and significance to them, and to establish their causal relations.

In humans and other primates, vision provides some of the most important inputs to these representational systems. Such systems are not linked directly to specific motor outputs but are linked instead to cognitive systems subserving memory, semantics, planning, and communication. Of course the ultimate function even of these higher-order systems has to be the production of adaptive behaviour. The distinction between systems of this kind and the dedicated visuomotor modules described earlier is that the former enable us to select appropriate courses of action with respect to patterns of visual input, while the latter provide the immediate visual control required to execute those actions."[88]

"To actually catch a ball, one must combine the eye's inputs with activation of the body's motor system to get the hands in the correct place. This complex process requires a set of visual-motor skills in the form of depth perception, saccades and pursuits, eye hand coordination, vergence, peripheral awareness and visual reaction time. These skills are amenable to training and therefore can be predicted to provide the athletes with a potential advantage over their counterparts.

Since, vision resides in the brain, any evaluation of the visual system without considering its effects on cognition and movement, is deemed incomplete. In totality, vision is a learned complex and developed set of functions that involve a multitude of skills and therefore, can be taught through specific training of the visual skills through an individual specific program …"[89]

"Perception is an active process of locating and extracting information from the environment and learning is the process of acquiring information through experience and storing information. Thinking is the manipulation of information to solve problems. The easier it is to extract information (perceive) the easier our thinking process becomes. (Forgus)
Visual information processing refers to the visual cognitive skills that allow us to process and interpret meaning from the visual information that we gain through our eye sight…..

Visual perceptual processing is subdivided into categories including visual discrimination, visual figure ground, visual closure, visual memory, visual sequential memory, visual form constancy, visual spatial relationships, and visual-motor integration."[90]

If we are going to post a letter we know the task cognitively. We can see ourselves posting a letter at our own mailbox but also at a *strange* mailbox abroad. Besides that we have an abstracted idea of the task in our mind. We know an object must be inserted into some kind of slot. That we have to make sure that the object becomes parallel to the slit and that if we succeed to make the Initial Phase of the last little throwing action the object will fulfil the task automatically. A letter doesn't need to be accompanied anymore once it is in the slot. The very last part of the action trajectory in this task relates to a very small throwing action.

Every Motoric Movement Action has many possibilities concerning possible action trajectories. A human chooses, out of the to him known possible action trajectories, the action trajectory which is most effective/efficient[91]. In an unknown task a human needs to know at least one possible action trajectory cognitively. Think about a child learning to tie his shoes and the follow up of tying all kinds of knots at a sailing ship.

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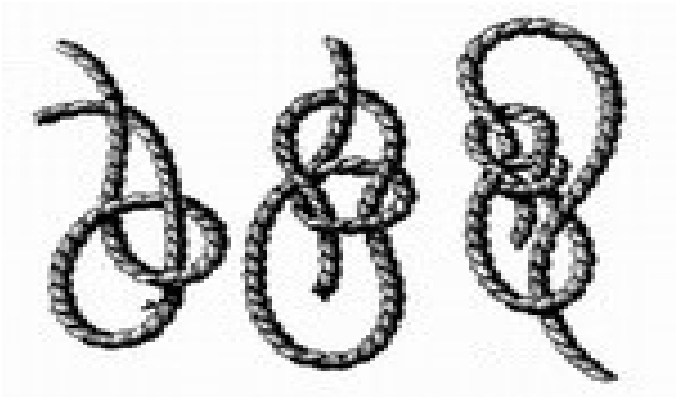
[88] The Visual Brain in Action; Milner A., Goodale M.; http://www.theassc.org/files/assc/2367.pdf
[89] Impact of Visual Skills Training on Sports Performance: Current and Future Perspectives; S. Khanal; http://medcraveonline.com/AOVS/AOVS-02-00032.pdf
[90] http://www.visiontherapy4kids.com/ContentPage.aspx?id=52
[91] The department of *Silly Walks* is an exception to that rule: https://www.youtube.com/watch?v=iV2ViNJFZC8

"The computational interventions of mind into the processes of perception and action have led to cognitive theories being labelled 'indirect'. It has been argued that the world cannot be known directly, but only through a stored representation of it in our minds. Due to the perceived inadequacy of the sensory systems, the assumption from this perspective is that the interventions of mind into the processes of perception and action need to be quite detailed."[92]



The cognitive basis shapes the template for if we are actually going to perform a task. All environment information will then be judged by the cognitive basis. So at a *new* mailbox we first make a tactical plan and make a perceptual action trajectory. With the actual action we are going to bring the letter in this action trajectory and we adjust the trajectory with the two processing processes of the perception. The dorsal and the ventral stream.

The cognitive basis in tennis relates to hundreds of action trajectories. Maybe even more. They can't be compared with daily activities. So they need to be learned. Each cognitive ability within the development of a player must be developed from universal to player specific to opponent specific. That means that at first a player needs to know what is the general acceptance of what can be universally applied in a game situation. Pretty soon a player needs to understand, out of a strength/weakness analysis, what suits the player best. In the end a player must be able to adjust all this cognitive knowledge in an opponent specific way. The ultimate goal is that a player just plays a little better than his opponent in a dosed way. Then the success rates of the action trajectories will have the highest outcome.

The cognitive basis is the maximal clear answer to the till now vaguely formulated descriptions of anticipation in tennis. Just like the game this was left to the player. Coaches tell players that they have to anticipate. They don't tell them how to anticipate.
The Game Action shows that it no longer belongs to the player. The Game Action appoints the coach as the first responsible person. Anticipation can be trained in an artisanal way. The coach must take care that a player will be able to anticipate. He has to learn a player all about the Motoric Movement Action of the opponent. An opponent can camouflage a lot but will finally have to reveal his choice for only one outgoing ball trajectory. A player needs to learn universal and opponent specific features of the Motoric Movement Action.
Besides that a coach has to provide a player with a large cognitive basis of reference ball trajectories which must serve as a blueprint to every greyscale of actual ball trajectories. And finally he must equip a player with all the success rates of all ball trajectories from universal to player specific to opponent specific.

[92] Williams, A.M.,Davids,K., Garrett, J.; Visual Perception and Action in Sport

The Tactical Tennis Action contains the same parts as the *old* tennis action of the current ITF training curriculum modules. However the appointing of the tennis action as a complex system will cause a major difference with the past. The execution phase (E) will no longer be the synonym for the technique but it will be the synonym for the execution of an outgoing ball trajectory.

2. The *old* Tennis Action

One of the main items of nowadays training methods within the KNLTB and the ITF is the Tennis Action. It is based on the new insight that tennis can be considered an open skill sport. Tennis is about many various game situations with lots of different sorts of ball trajectories. So a tennis stroke needs to be different all the time. A teacher who is teaching just *one perfect* forehand is doing his student a disservice. A player needs to learn a *functional* forehand. A forehand you can adjust to every game situation.

"The Teaching Games for Understanding (TGfU) approach developed by Bunker and Thorpe (1982) places a whole different approach to the teaching of games. The focus of the model is placing the student or athlete in a game situation where tactics, decision-making and problem solving is critical. Other variations and terminology include 'game sense', 'play practice' and 'game centred approach'.

Teaching Games for Understanding (TGfU) is a games based pedagogical model aimed at generating greater understanding of all aspects of games, while increasing physical activity levels, engagement, motivation and enjoyment in physical education lessons. (Forrest, Webb and Pearson, 2006), The model has been around in the literature since the early 1980s but it was not introduced to the Australian sporting community at large until 1996, when Rod Thorpe from Loughborough University England was brought out by the Australian Sports Commission (ASC) and conducted TGfU workshops around the country. However, ten years since its inception, it has made little progress within the teaching community in Australia (Pearson, Webb and McKeen, 2005).

TGfU places an emphasis on the play, where tactical and strategic problems are posed in a modified game environment, ultimately drawing upon students to make decisions. It places the focus of a lesson on the student in a game situation where cognitive skills such as 'tactics, decision-making and problem solving are critical… 'with isolated technique development utilised only when the student recognises the need for it' (Webb & Thompson, 1998. p.1). There is other terminology and variations of Bunker and Thorpe's (1982) 'teaching games for understanding'. Some of these include: 'Game sense' (ASC, 1999), 'Play practice' (Launder, 2001), the 'Games concept approach' (Wright, Fry, McNeill, Tan, Tan & Schemp, 2001, cited in Light, 2003) and more recently, 'Playing for life' (ASC, 2005).

TGfU is a holistic teaching approach that encourages student based learning and problem solving. It focuses on teaching games through a conceptual approach, through concepts, tactics and strategies rather than through a basis of skill, a technical games teaching approach or TGT. (Wright, McNeill, Fry and Wang, 2005)"[93]

So the execution phase is now preceded by two phases. The whole Tennis Action contains four phases. The Perception phase (P), the Decision phase (D), the Execution phase (E) and the Feedback phase

[93] P. Webb & P. Pearson; An Integrated Approach to Teaching Games for Understanding (2008); http://ro.uow.edu.au/cgi/viewcontent.cgi?article=1053&context=edupapers

(F). A player first has to realize in which game situation he is in and which is the most optimal ball trajectory to be played before he is going to execute anything. The development of this tennis action was a major step in the development of tennis. A player is now much better supported out of the game.

"The next scheme explains the tennis action: Perception → Decision → Execution → Feedback."[94]

Noticeable in this tennis action is the linearity. The phases follow each other step by step. The next phase begins when the previous stops. The perception must be finished before the decision takes place. The perception is not appointed any further. It says that it has to be done. That is it. It is not a description of a complex system.

At the end of this chapter it will become clear that the *D*, *E* and *F* phase can be maintained in that order. However the perception will rule over the whole process. The *P* starts even before the player hits the outgoing ball trajectory^{-1} (OBT^{-1}) and must create perceptual images of the result of OBT^{-1} over more than a cycle of a chain. The many perception processes which serve two tennis actions at the same time can never again be appointed in a linear way.

Besides that it will become clear that the *E* will stand for the execution of an outgoing ball trajectory. That part remained vague in the *old* Tennis Action. It was a synonym for technique but it was not allowed to call it that. Now it will become 100% clear that it is the execution of a ball trajectory and that it has nothing to do with technique. The Tactical Tennis Action is occupied with the task which ball trajectory will give the opponent the most problems and not with how it is executed. The whole Perception and Decision phase must and can lead to only one outgoing ball trajectory. How it is executed is part of the technique. The technique is not a part of the Game Action. The technique will be glued to the Game Action but on the outside.

The *old* tennis action will be completely absorbed into the Tactical Tennis Action.

3. The four basic tactical principles

In the curriculum of the KNLTB teacher's training there are four basic tactical principles[95] appointed.

"1. The *position* of a player.
2. The *ball trajectory* to be chosen.
3. The *movements* of a player.
4. The *behaviour* of a player."

*"The choice for a certain **ball trajectory** has to do everything with what you want to achieve with the ball, that means the meaning of the stroke. This has all to do with the character of the player. Most beginners have no style of playing yet but show their preferences for hitting hard, to place the ball really well or by avoiding risks. These aspects can be translated in a choice for a certain ball trajectory in the ball trajectory defining factors (BTDF): direction, ball speed and rotation."*[96]

It is worth noticing that all parts are discussed as separate phenomena. The ball trajectory is never related to the shape of the ball trajectory. It is confirmed that there is a ball trajectory but it plays no central role and it is not appointed into detail.

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[94] KNLTB curriculum A; p. 28
[95] KNLTB curriculum for A-level teachers p. 182
[96] KNLTB curriculum for A-level teachers p. 183 ad. 2

The four basic tactical principles will be fully absorbed into the Tactical Tennis Action. The Tactical Tennis Action is all about the intrinsic tactical value of the ball trajectories in relation to the position of the opponent. *Position*, *movements* and *behaviour* of the opponent play crucial roles in that relationship.

4. The Tactical Tennis Action

The Tactical Tennis Action combines all parts of the old tennis action and the four basic tactical principles in one complex system and even adds a few essential extra parts.

The main goal of the Tactical Tennis Action is to keep the opponent from lengthening the chain. It is all about the end of a ball trajectory and its relation to the opponent. The actual relationship but also the future relationship. A player needs to actually see the outcome of a ball trajectory but also has to make perceptions of the latent end shapes to be expected. These perceptions are crucial for actions to follow. That is the essence of the tactical game. The ball trajectories don't have to be connected in this tennis action but must be judged for their intrinsic tactical value in the relation to the opponent. The Actual Tennis Action takes place at the same time.

The Tactical Tennis Action follows the principles of every Motoric Movement Action. Tactics always contain two components. One component comprises the cognitive basis. The cognitive basis is the general knowledge we have about the task. It is the knowledge we can visualize at home sitting on a chair. The other component is about the actual tactical plan we have to make right before we are really going to execute a tennis action on the court. That is the Tactical Tennis Action. The cognitive basis is the fundament of the Tactical Tennis Action.

a. The Tactical Tennis Action – The cognitive basis

I. The Motoric Movement Action of the opponent

An opponent must also perform one Motoric Movement Action for one outgoing ball trajectory. Elite players can camouflage what they want but finally one shot must be executed. This action contains universal and opponent specific characteristics. A player should learn them in this order.

There is still no scientific research in anticipation to ball trajectories but there is a lot of research concerning the anticipation of the Motoric Movement Action of the opponent. Elite players anticipate more quickly and better than non-elite players to movements of the opponent before actually hitting the ball.

"Our perception of the environment and our responsive actions are more directly and intricately related in sports activities than in many other activities of daily living. Temporally constrained situations in many sports demand that players extract the most valuable sources of visual information and use that information to quickly anticipate the opponent's action. A recently published list of the 10 hardest things to do in sports ("Sportsline," 2003) included three sports in which task performance relies on that anticipation.

Highly skilled athletes are believed to possess the ability to perceive visual information from an opponent's motion pattern and use that information to anticipate subsequent events. A number of investigators have been interested in that conspicuous ability of expert players and have examined anticipation in activities such as tennis (e.g., Jones & Miles, 1978), hockey (Salmela & Fiorito, 1979), badminton (Abernethy & Russell, 1987), squash (e.g., Abernethy, 1990a), and soccer (e.g., Savelsbergh,Williams, Van der Kamp, & Ward, 2002)."[97]

"1 - In the past decades, many studies on visual search behaviour in ball and racquet sports have significantly extended our knowledge on the information pick-up and processing that precede a fast and correct decision during the game [1,2,3,4,5,6,7]. Although differences between sports exist due to the specific nature of each game, the general conclusion is that expertise is related to earlier pick-up of relevant information. As a result, expert players are able to adequately anticipate an opponent's action. This general rule has been corroborated in a wide variety of sports including soccer, tennis, badminton and others [8,9,4,10,11].
2 - At the level of the individual player, preparatory movements of the opponent contain visual cues that can help predict the direction and speed of the ball after the serve or the spike [13]. These cues seem similar to the visual cues in preparatory movements in racket games. In general, most actions in racket games have a proximal-to-distal development, and visual cues are usually found in this order, so gaze is directed in a proximal-to-distal sequence [14,5]. In a volleyball situation, occlusion experiments showed that experienced players are able to predict pass and serve direction better than novice players [15,16]. This indicates that experienced volleyball players 'read' the opponents' play better than novice players.
3 - Since there was no clear distinction in gaze behaviour between the groups, differences in reaction time and accuracy must have been the result of a superior information processing and decision making system. The use of visual pivots at the moment of reception and pass also suggests that participants retrieved a great amount of information through the use of peripheral vision. According to the holistic model of image perception [36,37], experts can extract information from widely distanced and parafoveal regions. So it appears that the three groups used a similar gaze strategy, but that elite players are able to subtract more relevant information by using an extended visual span and are able to link this information better to task-specific and procedural knowledge of the volleyball game play."[98]

The development of the cognitive basis is crucial and needs a lot of specific attention in raising elite players. Every stroke needs attention but I want to highlight the return on service (ROS). This game situation is a structural fact in matches. The success rate of the return will make a defined contribution to future wins.
That is why I plea for building an image library containing serve executions of the players in the top 100 (WTA/ATP). A data centre where all the services of each player are stored. All over the world a player must be able to consult the library for the next match tomorrow. The clips must be taken from the perspective of the returner. The key movements of every Motoric Movement Action can be highlighted with a colour. Besides the Motoric Movement Action the shape of the ball trajectories and their specific characteristics must become clear.

"Postural cue training. *The solid empirical evidence demonstrating that expert performers use postural information sources such as an opponent's movement pattern to anticipate likely ball flight (e.g., direction of a tennis stroke or soccer kick) provided researchers with a logical starting point for the design of sports-specific decision making training approaches."*[99]

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[97] Shim, J., Carlton, L., Chow, J.,Chae, W.; The Use of Anticipatory Visual Cues by Highly Skilled Tennis Players
[98] Vansteenkiste, P. & Verborgt, B.; Cue usage in volleyball: A time course comparison of elite, interm. and novice female players; http://lib.ugent.be/fulltxt/RUG01/001/459/085/RUG01-001459085_2011_0001_AC.pdf
[99] Farrow, D. & Raab, M.; Receipt to become an expert in decision making

In a match preparation a player must be able to get acquainted with the reference images of the execution of all services and ball trajectories. The outcome of these ball trajectories will provide the first indication of actual return positions. Building up such a collection is not without costs and takes a lot of time. It is more profitable to build it for top players. Besides that the higher the position of a player the higher the chance becomes that he will meet the same opponent more frequently.
Besides this opponent specific library it is necessary to build an universal image library for beginning elite players. In this library it is important to highlight crucial key moments. Maybe with a color. These reference images must provoke an optimal anticipation. First they must be reinforced endlessly during training sessions and that will in the end ensure that a player knows the game situation inside and out. The positive consequence of a universal library is that players who actually reach the top are already familiar with the template. For years they practiced the same image *language* and can continue this now with the opponent specific library.

"Cues can be emphasised using film-based training programmes (e.g. Burroughs 1984; Christina, Barresi and Shaffner 1990; Williams and Burwitz 1993) or by highlighting important information during training such that they stand out from background distractions (see Maschette 1980). This latter approach can be achieved by using colour coding schemes to represent key cues. For instance, if the ball toss is an important cue in the tennis serve then an opponent can wear a brightly coloured glove or wristband to draw the learner's attention to this area of the display (ibid.). Similarly, the racket head can be painted with a bright colour so that the learner can easily pick out relevant racket angles as the ball is struck (for further information on improving anticipation in sport, see Abernethy and Wollstein 1989; Maschette 1980; Williams and Davids 1994)."[100]

II. Reference ball trajectories

In tennis there are over hundreds of possible action trajectories. So it is useful to not learn all the answers like in mathematics but to understand the rule. This is a plea to work with reference ball trajectories. Reference ball trajectories are the perfect shapes of ball trajectories which are the universal answers to a tennis problem in a game situation.

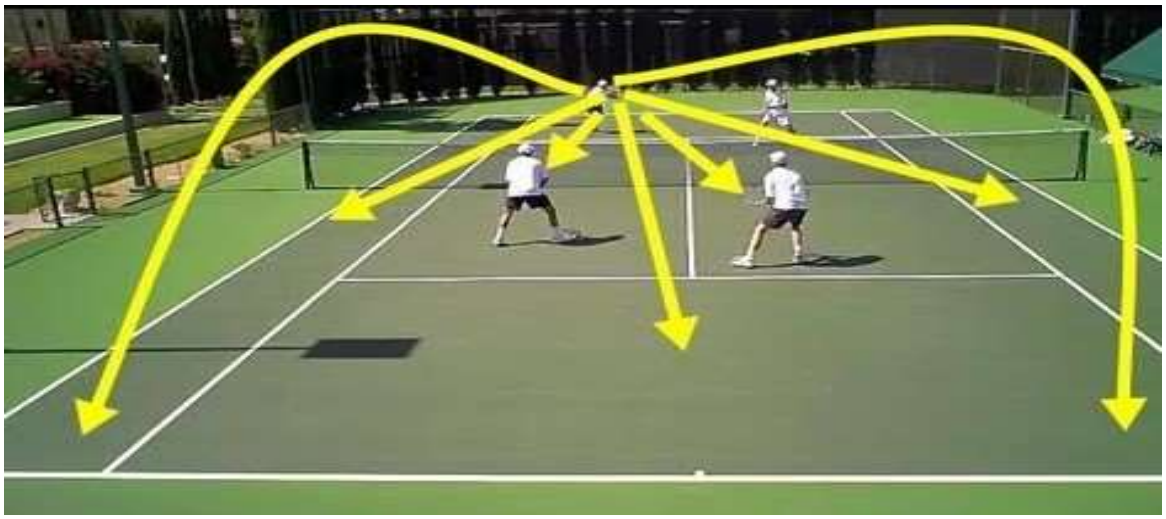

Image: reference ball trajectories in a game situation in doubles

[100] Williams, A.M., Davids, K., Garrett, J.; Visual Perception and Action in Sport; p. 55

As an example I will appoint the short cross passing shot, in singles, from the position of the player in the back of the court who saw the opponent approaching the net after a long line approach shot. The short cross passing shot is one of the four conventional reference ball trajectories in this game situation[101]. The ball trajectory short cross has specific characteristics. The ball trajectory doesn't need a lot of pace and the ball trajectory has to really curve downwards once it passed the net. It must be delivered well *into the mailbox* (the space between the net and the net player). The curve of the ball trajectory must contain a certain inflection point and has to move away from the net player.

A player needs to know all the specific characteristics of all reference ball trajectories. Also the abstractions of the tasks at hand. It is not enough to only know how to hit the perfect reference ball trajectories. Regularly a player will not be able to reach the ball in a perfect way. It doesn't matter how ugly a player performs a shot if he can make a ball trajectory with the *how* and the *why* it will fulfil the task. The abstraction of the task takes care for maximal creativity under all circumstances.

III. Success rates

Every Motoric Movement Action has a success rate. That is especially valid in tennis. Even the most easy ball trajectory will go wrong some times. But if you want to score points or want to force an opponent to make an error you will not be allowed to make safe ball trajectories. The chance of applying pressure in that way becomes minimal. In tennis you must take risks in order to gain points in return. The dualism in ball trajectories is also involved in here[102]. A player must learn the fixed correlation between ball trajectories, game intentions and percentages.

Tennis is a game of mistakes. It is played with a small ball on an admittedly fairly sized court but the ball speed is high and there is an opponent who doesn't want to be your friend during the match. So it is not a problem that a player makes mistakes. The only important thing is that your percentages remain better than your opponent. You only need to win from one opponent that day and not from all players. In matches where they played 150 points all together you probably win 7-6, 7-5 if you won around 80 points[103].

Tennis is all about the optimisation of percentages. Maximisation will take place if a player just plays a little better than his opponent. That will produce the highest percentages. If a player takes unnecessary risks his success rate will drop with a factor. The dualism in ball trajectories clearly shows that. So in the end a player needs to learn to finish matches in a dosed opponent specific way. The first phase is universal and the second is player specific. That is why the cognitive basis must provide a player with all the percentages belonging to all the different ball trajectories in all game situations. This must also be trained from universal to player specific to opponent specific.
Besides that a player needs help with strategies on the court. Very complicated considerations concerning percentages must be established by a coach[104].

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[101] See image p. 30 - *game situation 1*
[102] Chapter 10.5
[103] Federer has a lot of records. He also possesses the dubious record of most wins where the opponent scored more points in total. http://www.theatlantic.com/entertainment/archive/2014/01/what-every-pro-tennis-player-does-better-than-roger-federer/283007/
[104] See paragraph 6.5 *Strategies*

This section about success rates in this paragraph is an essential part in tennis nowadays. Many mental problems occur because players don't have realistic expectations about percentages and don't know the essence of the tennis score.
To hit a tremendous winner to an impossible ball is always very nice. But you can't think that you can win matches with it. The cognitive basis must contain such realistic percentages that a player knows that the average of percentages will become the outcome of the match. He must learn to trust the percentages. Even when things are a little down. It is still very common that if something goes wrong due to the fact that the opponent hits two somewhat lucky balls that a whole game situation is avoided for the rest of the match.

"As well as their enhanced ability to extract task-specific contextual information from the display, research suggests that skilled performers are able to make use of expectations or situational probabilities to facilitate anticipation in sport. Early research was carried in the laboratory using choice reaction time paradigms. These studies demonstrated that reaction time is directly proportional to the amount of 'uncertainty' or information present within a display (e.g. Hick 1952; Hyman 1953). Moreover, it has been suggested that the performer can significantly reduce this level of uncertainty through practice (see Mowbray and Rhoades 1959). An argument is that experienced performers can use their superior knowledge base to dismiss many events as being 'highly improbable' and can attach a hierarchy of probabilities to the remaining events (Gottsdanker and Kent 1978). In this way, sports performers can reduce uncertainty regarding 'what' event will occur (i.e. event uncertainty) and 'when' it will happen (i.e. temporal uncertainty)."[105]

Sometimes reference ball trajectories in one game situation have equal success rates but most of the time they are different. Success rates follow the dualism in ball trajectories. A player must be able to appoint the hierarchy of success rates. An additional benefit from that is that a player will sooner reach a decision because he will be able to judge the *probability* of an option to occur.

b. The Tactical Tennis Action

If we are really going to execute a Motoric Movement Action we first make a tactical plan before the actual action occurs. The Tactical Tennis Action is the tactical plan for the Actual Tennis Action. The cognitive basis is used as a template.

There is a possibility that you could think there might be a linear progress. First the tactical plan and then the actual execution. In tennis that is a mistake. Tennis combines two Motoric Movement Actions who are divided in time. There is a different tactical plan for the catching and for the throwing. The tactical perception processes are preceding the actual perception processes but are again occupied with future perceptions if the actual action is executed. And that goes on and on till the chain stops and the rally is over. The perception processes even cover more than one cycle of a chain at the same time. And then we are still talking about a normal rally and not about (scoring) patterns[106].

The Tactical Tennis Action has the assignment to make deductions as soon as possible till only one outgoing ball trajectory with an optimal Game Intention remains. So the description of the Tactical Tennis Action towards the outgoing ball trajectory can be considered one subtraction exercise. The more the process progresses the more possibilities must disappear. The extra knowledge of each progression must be added to the cognitive basis. So with each progression the knowledge about the intrinsic tactical value of the incoming ball trajectory increases. For a player it is important to draw conclusions as soon as possible for the sake of maximal anticipation.

[105] Williams, A.M., Davids,K., Garrett, J.; Visual Perception and Action in Sport; p. 118
[106] Chapter 10.7

I will now report in detail all the tactical perception processes in every phase during one cycle of a chain.

I. The phase before the outgoing ball trajectory^{-1} (OBT^{-1})

Before a player hits the outgoing ball trajectory (OBT^{-1}) he can visualize the end shape of that ball trajectory based on his intentions. If you combine this with opponent specific information and information about the current game situation a player will be able to tell a lot about the coming game situation. Even more so the OBT^{-1} is causing the greatest reduction in choices for the OBT$^{(0)}$. Now a player will already be able to make a global image of the incoming ball trajectory.
This phase is an important expansion of the old tennis action. A player must realize that with the outgoing ball trajectory^{-1} he can make a global image of the coming game situation and that at that stage he is one step in front of the opponent.

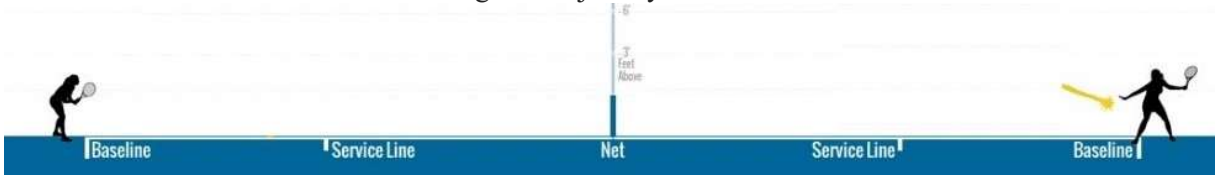
II. The Motoric Movement Action of the opponent till the main phase of the stroke

Before the OBT^{-1} will reach the opponent the opponent has to perform the same catching and throwing actions like the player. The opponent is also forced to work towards only one choice of an outgoing ball trajectory and he will have to reveal this choice by actual movements. The perception of the possibilities out of the previous phase must now serve as a template for the actual movements in this phase. Now it becomes *very clear* to what global spot the opponent is moving. His racket is in the preparation phase of the swing and also gives a little information by now. At this moment a player should visualize reference ball trajectories from this global spot. At this moment that is a rather rough estimate. In the next phase that becomes very precise.

III. The Motoric Movement Action of the opponent from the main phase of the stroke to the Initial Phase of the incoming ball trajectory

In this phase the opponent clearly has chosen one particular intersection point and his racket is now in the main phase of the swing. Now all reference ball trajectories must be visualized from this point. So again this takes care of a reduction in possibilities of incoming ball trajectories. The reference ball trajectories that remain must be visualized more precise than in the previous phase. From the main phase of the swing and the relationship between the racket head and the contact point one can make a global perception of the shape of the incoming ball trajectory and the ball trajectory defining factors (BTDF).

IV. The Initial Phase of the incoming ball trajectory



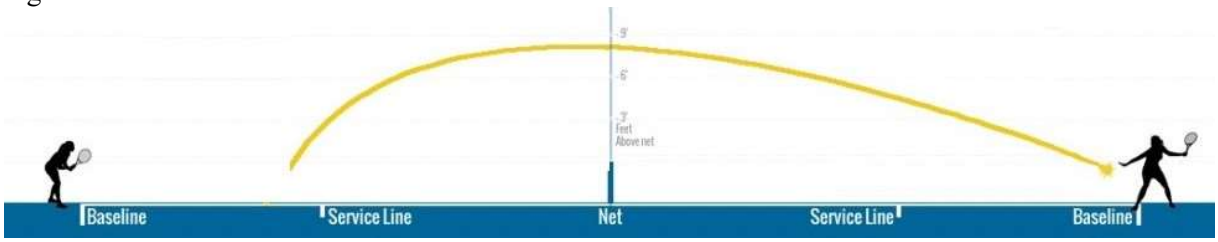
During the Initial Phase all perceptual perceptions are confirmed in only one incoming ball trajectory. An opponent must and can only produce one ball trajectory. All conditions for a whole ball trajectory must be added during that phase. So the Initial Phase harbors all intrinsic tactical factors. Based on all

previous information and the information from the Initial Phase a player must now be able to establish a clear global image about the tactical implications of the end of the incoming ball trajectory.

V. The incoming ball trajectory till ± 2 meters before crossing the net

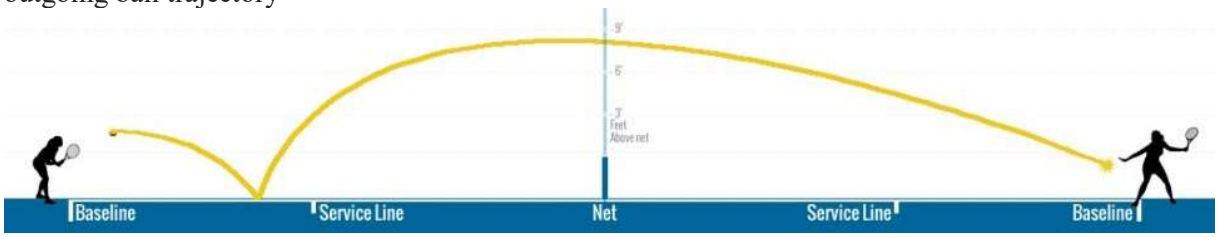
In this phase the player gets a definite answer about the movements of the opponent. Till that time all reference ball trajectories must be kept open.

VI. The incoming ball trajectory from ± 2 meters before crossing the net till ± 2 meters after crossing the net



Now that the movements of the opponent are clear one of the reference ball trajectories will be chosen as a favorite based on the optimization of Game Intentions. However the rejected ball trajectories must remain stand-by for eventual emergency situations (unsuspected movements of the opponent, a bad bounce, a sudden breeze of the wind, a slippery step).

VII. The incoming ball trajectory from ± 2 meters after crossing the net till the Initial Phase of the outgoing ball trajectory



In this phase the Actual Tennis Action will lengthen the chain of ball trajectories with one outgoing ball trajectory. That is a very active demanding phase. So during this phase the Tactical Tennis Action slows down a little. As soon as possible it continues making perceptions. Perceptions of the anticipation of the opponent to the beginning of the Motoric Movement Action of the player needed for the execution of the outgoing ball trajectory. Again this phase will render the global expectations a player must create of the end of an outgoing ball trajectory in relation to the opponent. And that makes the circle complete.

5. Strategies

There must be a special place for strategies. In sports, game situations occur which are very complex. Think about the penalty corner in field hockey. There is a special assistant coach high in the stands to analyse the attack patterns and movement patterns of the defenders and passes the information to the senior coach. In ski sports there is a specialist who can adjust the wax to all weather and snow conditions. That is a person with years and years of experience. Experience you can't gain in your time as a player.
A player can obtain a lot of cognitive basis knowledge but the complexity of some game situations require expert knowledge. In some cases players need help from the outside world. This is also the case in tennis. A player has to be trained to implement the offered information quickly.

a. Service strategies

"The second and more important effect is that the laws of physics are working against the server as the serve speed is raised. The higher the ball speed, the smaller is the "acceptance window" for a ball going in. However, balancing all of this, when the hard serve does goes in, the server is more likely to win the point. What strategy should be adopted? What should a tennis coach tell the player? Smash the ball hard? Play it safe and get the serve in as often as is possible? Hit the ball hard, but not as hard as possible? Hit the ball only hard enough to get in 65% of the first serves? The answer is not obvious, and depends on a number of factors."[107]

The service is by its very nature a stroke we consider in percentages. A higher percentage in consistency is often inversely proportional to the percentage of profit gained by the service. A player knows the universal percentages and especially the player specific percentages. But in exceptional cases where f.e. Nadal, Djokovic, Murray or a Federer are at the other side of the net with exceptional high return percentages cross-checking percentages is a form of rocket science.

b. "To the Good Player the Ball Comes"

"The idea, of anticipation, is not new. In 1690, Furetière's universal dictionary of the French language already contained the metaphorical expression "to the good player the ball comes" to describe the amazing ability of real tennis (precursor of the modern game of tennis) players to get into position early in the ball's flight. By observing the way an opponent strikes the ball, players can pick up useful information to anticipate the direction of their shots. There is another specific source of information that could potentially play a key role in the anticipation of tennis strokes: it is linked to the fact that players can, by controlling rallies, influence their opponents' shot selection.
Players should not just react to their opponents' shots by deducing anticipatory elements from their knowledge of their opponents' game; they should also anticipate events by inducing them. History shows that anticipation is much more than using your knowledge of your opponent's playing patterns or reading visual cues from the way they strike the ball." [108]

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[107] Serving Strategy, Brody H.; ITF Coaching & Sport Science Review Issue 31, (2003)
[108] Crognier, L., Féry, Y.; "To the Good Player the Ball Comes": A Reflection on Player-induced Anticipation; ITF Coaching & Sport Science Review 37 (2005)

In men's doubles at the highest level the net player has a proactive role in every game situation. Opponents must be constantly surprised by well-planned movements. The ultimate goal is to manipulate the opponent in such a way that they play alternative shots at the moment you want it.

At the highest levels in doubles this is indispensable. Lower levels in doubles quickly switch to standard setups. In singles at all levels it is scarcely used. Returns are executed from just one spot. They scarcely use the element of manipulating the situation in such a way that the ball comes to you *automatically*. By active positioning and aimed perception you can crawl inside the opponent's mind. An opponent must take your active positioning and movements into his considerations and not experience a passive player.

A player needs to feel and to anticipate where an opponent is going to look for alternatives. It is important that players get educated in this part universally and learn where a specific opponent tends to. There is a link with strategies in poker. *Cold reading* concepts play a part in here.

"There are several key skills both poker players and cold readers have in common:

- *Knowing odds and probabilities and calculating these on the fly.*
- *Being able to read people, i.e. body language and facial expressions.*
- *Having a keen understanding of human nature and behavior.*
- *Being able to evaluate what they have learned and use it to their advantage."*[109]

Universal knowledge about tendencies of an opponent must be checked to actual success rates. There is a small number of players who tend to play better if you are going to manipulate them. It is better to not wake up these players.

[109] http://www.skepticreport.com/sr/?p=446

Chapter 7 – The Actual Tennis Action

1. Introduction
2. The Actual Tennis Action with an incoming ball trajectory with a bounce
3. The Actual Tennis Action with an incoming ball trajectory without a bounce
4. The new features

1. Introduction

The Game Idea in tennis forces players to make chains of ball trajectories and at the same time to prevent the opponent from fulfilling this task[110]. The Actual Tennis Action is only concerned with the first part. She is observing the incoming ball trajectory as the only existing incoming ball trajectory in the world at that moment. The Actual Tennis Action must connect the incoming ball trajectory with one specific outgoing ball trajectory. Like the incoming ball trajectory, the outgoing ball trajectory is also the only existing ball trajectory at that moment. The Actual Tennis Action isn't concerned about the shape or the Game Intention of the ball trajectory. In the preparatory phase out of the cognitive basis and the Tactical Tennis Action there has been made a decision for one outgoing ball trajectory. In a sense the Actual Tennis Action is the sole executioner of the consignment the Tactical Tennis Action formulated.
If you look at the DemoClip you will at first see two players executing the whole Game Idea. When the screen turns black and the ball trajectories only remain you see the Actual Tennis Action without players and Game Intentions. Then you only witness the connecting of ball trajectories. As if that was the only goal.

Just like in all Motoric Movement Actions the actual action is influenced by the two processing processes of the perception. The action trajectories are mutually controlled by the ventral stream and the dorsal stream. The ventral stream is mainly concerned about the ball trajectory. She continuously tries to predict the near-future shape of the ball trajectory out of the manifest part of the ball trajectory. The dorsal stream mainly observes the ball. It checks the actual place of the ball in regard to the perception of the ventral stream. Deviations are controlled with new perceptions of the latent ball trajectory in an ongoing mutual process.

The Actual Tennis Action is a combination of two Motoric Movement Actions. A catching and a throwing action[111]. A description as a complex system must comply with the rule of universality. That is why the Actual Tennis Action completely follows all characteristics which were appointed in the general Motoric Movement Action. Only in tennis two Motoric Movement Actions must be combined. It is important to notice that they are separate and different actions and in principle they have no relationship. The only thing is that the throwing must be executed directly out of the catching. Now the statements of Mike Barrell become clearer.

"Tennis is often listed as a "sending and receiving" sport. In fact I would change that to "tennis is a receiving and sending sport!" Only the serve starts with the sending process. The remaining shots all start with the reception process. Reception is the core skill of our game and without it you just can't play!" [112]

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[110] Chapter 3.4
[111] Chapter 5
[112] Barrell, M.; Incoming!: Reception skills; ITF Coaching & Sport Science Review Issue 51, (2010)

The Actual Tennis Action will provide many new perspectives. Consistent reasoning with the Game Idea as a premise gives the ability to appoint the whole task in actual actions which are demanded from the player. The Actual Tennis Action makes perfectly clear what must and what must not be reinforced. Everything what doesn't belong to the task will be appointed as feeding *self-1*. Reinforcing those tasks in training must be rejected. The proposition is that flow and playing in the zone only occur if a player only reinforces those tasks which really belong to the Game Action. Than the body of a player experiences a feeling of harmony and balance.

We were suprised by how explicitly eye movements were related to actions. Hayhoe (2000) concluded 'The role of vision from moment to moment is determined almost exclusively by the current stage in accomplishing the task. There appears to be little room for other functions.' This 'do it where I'm looking' strategy also applied in the somewhat less natural block-copying task of Ballard, Hayhoe, Li, and Whitehead (1993), where every movement and checking operation was achieved via an eye movement, with little or nothing held over in memory across fixations.[113]

2. The Actual Tennis Action with an incoming ball trajectory with a bounce

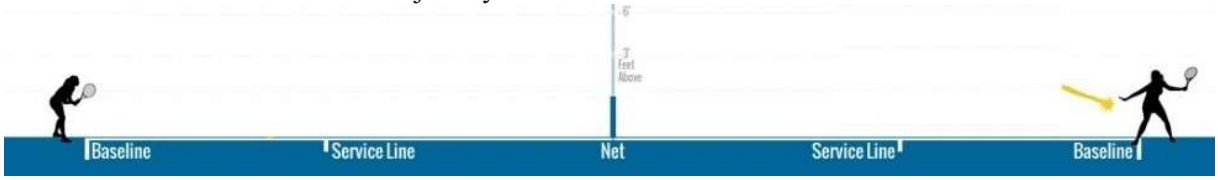
In the Actual Tennis Action one whole cycle of a chain of ball trajectories will be regarded and the start is just before the opponent hits.

a. The phase of the ball trajectory before the hit of the opponent

The shape of the end of the outgoing trajectory^{-1} (OBT^{-1}) provides with every time-unit different possible options for the opponent. Before a player hit the ball he created expectations concerning the outcome of the ball trajectory. In this phase the player has to check if the actual ball trajectory meets up with these perceptual expectations and which intersection point the opponent approaches to make his outgoing ball trajectory. In that task a player needs to check the body language of the opponent.

An opponent will reveal universal and opponent specific characteristics in the execution of his Motoric Movement Actions. So out of the tactical base a player will be able to make perceptual images of movement trajectories (e.g. movement patterns, racket trajectory) the opponent will use when he starts to execute his Motoric Movement Actions. The ventral stream mainly considers the perceptual action trajectories an opponent is going to make. The dorsal stream mainly considers the object in these trajectories. She mainly considers the actual positon of the opponent in the movement trajectory and the actual place of the racket in the racket trajectory. Both streams show again the mutuality as within every Motoric Movement Action. The perception processes in this phase will already reduce the image of possible incoming ball trajectories drastically.

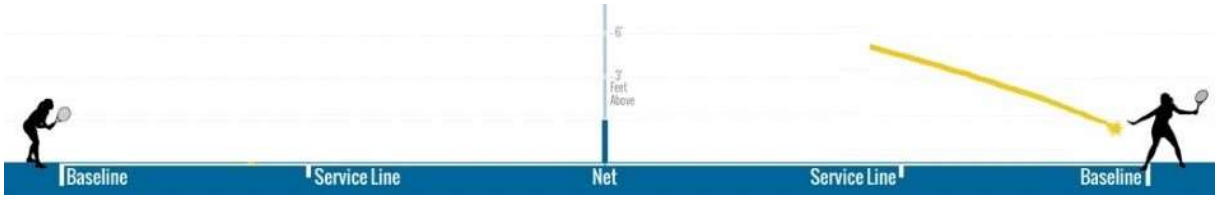
b. The Initial Phase of the ball trajectory



[113] Michael F. Land, Mary Hayhoe; In what ways do eye movements contribute to everyday activities? http://ac.els-cdn.com/S004269890100102X/1-s2.0-S004269890100102X-main.pdf?_tid=f270a256-99c8-11e5-adbf-00000aab0f02&acdnat=1449152584_01e6d4abbe3f4f3cb29ef26d8717f6ec

The actual perception of the Initial Phase is of great importance. During the Initial Phase the whole ball trajectory is shaped. On the basis of tactical information, the main phase of the swing of the opponent's racket and the Initial Phase a player can make a very precise picture of the global shape of the incoming ball trajectory. This is possible because the processing processes make it possible to perceptually lengthen the Initial Phase of a ball trajectory. In this way players get a *view* of the latent part of the incoming ball trajectory.

c. The phase of the ball trajectory between the Initial Phase till halfway the opponent's court

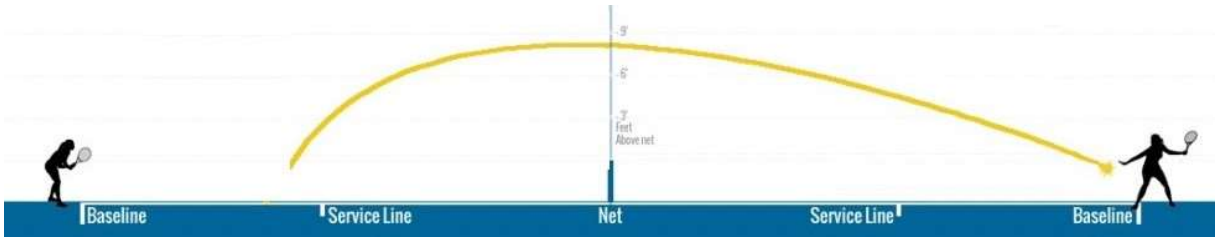


Soon after the Initial Phase a player will be able to visualize all possible outgoing (reference) ball trajectories with their specific intersection points out of the global perception of the outcome of the incoming ball trajectory. Mainly the processing processes towards the ventral stream are responsible for this perception. The processing processes towards the dorsal stream keep *their eye* on the ball. They check if the ball actually follows the perception of the proposed ball trajectory. If it deviates from that ball trajectory the dorsal stream takes care that the perception is adjusted. The ventral stream will then implement the new ball trajectory right away and is being checked again by the dorsal stream. It is an ongoing mutual working process.
In this phase the perception of the latent ball trajectory is very global. A precise prediction is just not possible but it is also not needed at this moment. Now it is important that the perceptions are diminishing the possibilities in a very rigorous way and lead the action to a definite result.

d. The phase of the ball trajectory from halfway the opponent's court to the net

If the ball in a ball trajectory approaches the net the actual ball trajectory will become much clearer. Possible deviations diminish exponentially with every time-unit. On the basis of tactical information and the perceptual shape of the end of the incoming ball trajectory a player will now make a decision about the outgoing ball trajectory. With this decision there is a precise visualization of the global place where the two ball trajectories will have their intersection points.

e. The phase of the ball trajectory from the net to just before the bounce

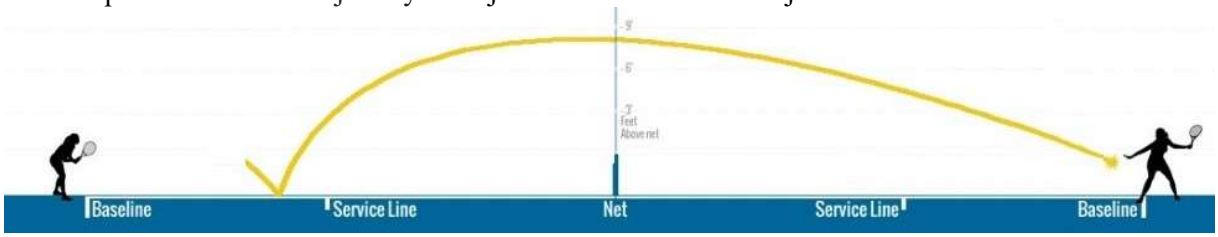


In this phase the possible latent intersection points are reduced exponentially. Now there is just a little zone left where the ball will actually show up for the outgoing curve.
In the phase around the bounce the perception must become more and more precise. The phase before the bounce provides essential information for the phase after the bounce. This phase contains the most important actual receiving information. The perception processes towards the dorsal stream become more important because the actual place of the ball guides the actual motoric movement actions.

Till the final hit the perception processes towards the ventral stream will keep on making perceptions of the incoming ball trajectory. But once the major part of the incoming ball trajectory is manifest the importance of these perceptions is reduced in relation to the perception processes towards the dorsal stream. Because two Motoric Movement Actions, a catching and a throwing task, are involved the perception processes towards the ventral stream will for a great deal switch their attention to the perception of the shape of the outgoing ball trajectory before the incoming ball trajectory bounced. This visualization is essential because it is again the guide for the perception processes towards the dorsal stream. This visualization must provide the perception with an intersection point to make a connection to the outgoing ball trajectory. A throwing task is only concerned about the intersection point and the Initial Phase.

The perception processes guide the execution of the actual stroke. In this phase the racket is at the end of the preparation phase and will soon start the main phase of the swing.

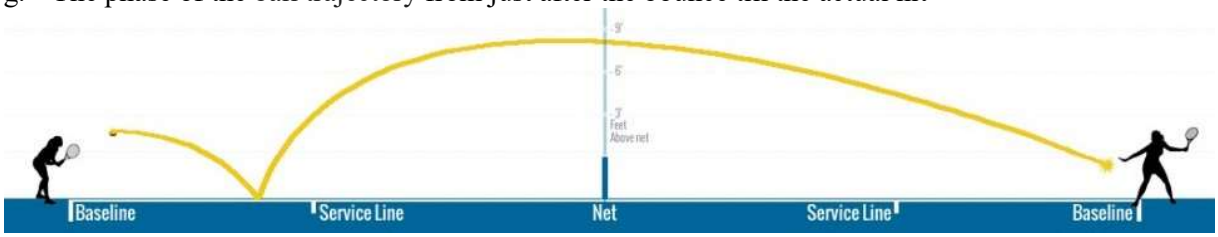
f. The phase of the ball trajectory from just before the bounce to just after the bounce



In this section and the next sections the most new insights are appointed. The insights are mainly in contradiction with leading doctrine in the world of tennis.

In this phase the player starts to actually execute the outgoing ball trajectory. The racket just finished the preparatory phase of the swing and is now in the beginning of the main phase. After the saccade (eye jump) the player really transitions from catching/receiving to throwing/sending. That doesn't mean that the catching stops completely. The perception processes of the catching remain working till the ball is finally hit. The sending becomes more dominant because it needs more attention than the receiving.
Now the perception processes focus mainly on the virtual point where the Initial Phase of the outgoing ball trajectory must be created. The intersection point of the two curves. The processing processes towards the ventral stream created that perception. The processing processes towards the dorsal stream actually see the ball now in peripheral vision coming up from the bounce point and let the ball come to the intersection point.

g. The phase of the ball trajectory from just after the bounce till the actual hit



The perception is now mainly in service of the throwing/hitting. The only part of a ball trajectory a player can influence is the Initial Phase. The visualization of the whole ball trajectory is a leading guide in that task. The outcome of the ball trajectory in relation to the opponent gives the tactical information to fulfil the second part of the Game Idea. To prevent the opponent from continuing the chain.

But in this phase the ball is not there yet. It still has to come to the virtually constructed intersection point of the two ball trajectories. The perception processes which take care of the receiving let the ball go through the very little last latent end of the incoming ball trajectory until the intersection point is reached. The perception processes which take care of the execution of the outgoing ball trajectory are laying there in wait till the ball appears in there. They are waiting there from the time the eyes made the saccade. If the ball appears in the intersection point the signal is given to the execution of the Motoric Movement Action to actually hit the ball.

So like appointed in every throwing action the perception processes are not actually aiming at a target or over the net. They are totally occupied in shaping an outgoing ball trajectory. A ball trajectory which will automatically go over the net and into a target area.

h. The phase of the outgoing ball trajectory just after the hit till the net

The Actual Tennis Action now checks if the ball is actually hit well into the perceptual ball trajectory. Now the perception processes have to compare the actual outcome with the previous desired outcome. If the ball follows the perceptual wanted ball trajectory than no tactical changes have to be made. If that isn't the case the deviations should influence the tactical plan. Sometimes a player needs to drastically change tactics if f.e. the ball hits the net.

i. The phase of the outgoing ball trajectory from the net till the opponent

In this phase the outgoing ball trajectory is almost manifest. Adjustments to deviations are implemented in the tactical plan. The tactical plan absorbs adjustments in a blink and behaves then like it was always like that. Perceptual images are important in guiding but the actual place of the ball is leading.

With this last phase the cycle of the Actual Tennis Action is complete. The Tactical Tennis Action is already generating new perceptions of images further on in the cycle until the end of a chain.

3. The Actual Tennis Action with an incoming ball trajectory without a bounce

All existing volleys in tennis follow the Motoric Movement Action and more specific the catching action[114]. The actions mentioned above can be copied completely.

It is important to notice that also in here there is an early visualization of an intersection point with an outgoing ball trajectory. It is the main goal of all actions that the ball will come to that virtual point. The racket head must always be the first one to arrive there. It doesn't matter how long that is. As long as the ball will be able to come to the racket.

It is also important to notice that intersection points in volleys are closer to the eyes. The vision on the shape of the ball trajectory is more limited than with groundstrokes. A good position sideways to the ball trajectory will guarantee a good vision on the shape of the ball trajectory.

4. The new features

- In the eyes of the Actual Tennis Action there are just two ball trajectories existing in the whole world. The specific incoming curve and the specific outgoing curve in one cycle which are appointed by the Tactical Tennis Action. At that moment tennis is not an open skill anymore. These curves must be received and created in a very limited way. Although the player will be free to choose the technique he wants there will be strict boundaries in the execution of the technique chosen.

- The perception processes towards the ventral stream make perceptual images of latent intersection points in all strokes. A player must allow the ball to come to that point. Even if the player has to move he has to fulfil that task.

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Images: Who says that if sports*people* seem to gaze that they are actually not making perceptions? Could it be that the diver visualizes her *in*-jump into her dive trajectory? Could it be that Federer hits the incoming ball into a visualization of the outgoing ball trajectory and that he is making all kinds of perceptual images?

- The outgoing ball trajectory is shaped during the Initial Phase close to the player. Nowhere else. A player has to reduce the outgoing ball trajectory he wants to create to the beginning of that ball trajectory. A player must focus his attention or his perception processes to that initial process. During

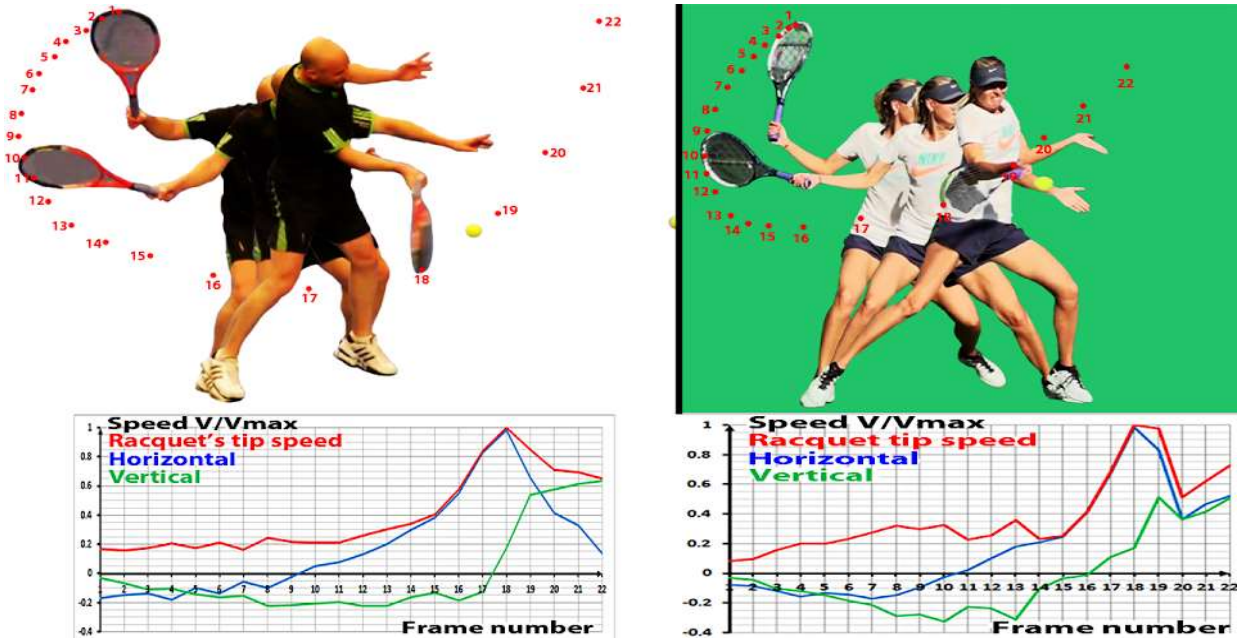
[114] Chapter 5.2a

that phase he must hit the ball into the tactical visualization of the ball trajectory. The ball trajectory is already there. The ball only has to actually follow it.

- Before a player makes a decision for an outgoing ball trajectory he must have visualized the outcome of that ball trajectory after the bounce. That is the only thing the game demands from him. A player must absolutely not check if the ball goes over the net or in the opponent's court. The only thing he has to check is how the visualized shape of the Initial Phase relates to the actual shape of the ball trajectory and to follow up any deviations with tactical adjustments.

- After the saccade the perception processes switch from catching to throwing. These totally different Motoric Movement Actions have to be combined in an unnatural way. So the actual observing of the ball is part of two processes. The actual observing is only responsible for the actual action moments. The perceptual action trajectories lead the whole process.

- Just before the hitting of the ball the two Motoric Movement Actions are tied together during the Initial Phase. The receiving will continue until the ball is finally hit. To optimise both processes there is a need for a high quality of receiving and there is a need for high quality in the sending of an outgoing ball trajectory with an optimal Game Intention. The receiving benefits from letting the ball come to the racket in a relaxed way. The sending benefits from a maximal acceleration from the racket. This dualism explains the existence of differences in dynamics concerning the racket acceleration in tennis.
  This is shown in the two added photo studies. The red lines of the speed of the racket head clearly show an inflection point. In that point the (slower) speed of the receiving transitions in the (faster) speed of the sending. The horizontal velocity lines have the same dynamics. That is logical because in tennis speed is dictated by the x-axis. The vertical velocity lines have a regular appearance. The y-axis is mainly responsible for making the shape of the ball trajectory. There is no need there to disrupt the linear receiving process of the ball.



This is in great contrast with the current thinking in tennis about dynamics in strokes.

- In itself the Actual Tennis Action is a complex (sub)system just like the technique (Te) and the Tactical Tennis Action. The Tactical Tennis Action is serving her because out of the many options the Tactical Tennis Action has to come forward with only one ball trajectory for the Actual Tennis

Action. On the other hand the Actual Tennis Action is just the *dumb executioner* of the Tactical Tennis Action. The technique is just executing the Game Action.
This makes that the Actual Tennis Action can very well be trained separately as a (sub)system. Of court with MindTennis and on court without the Tactical Tennis Action in exercises with reference ball trajectories.

- Intuitively speaking the Game Action lives up more to the game of elite players. The fact that they seem the gaze without any thoughts doesn't mean that they are not actually visualizing lots of perceptual images.

- In contrast to the *The Quiet Eye*[115] the Actual Tennis Action provides a description of very active eyes. There are many perception processes which are looking for information continuously. They even overlap more than one cycle. Actual perception processes at one moment look at the actual place of the ball in a ball trajectory while other perception processes visualize the outcome and the consequences of that ball trajectory. The Game Action is a complex and full description of what is going on in elite players. That makes a sharp contrast with the naïve linear explanation of Vickers.

  "Complex tracking and aiming tasks such as hitting a baseball, returning a tennis serve, and receiving a volleyball serve are characterized by three distinct segments (Vickers & Adolphe, 1997), beginning with the detection phase (i.e., determining the flight path of the object), followed by the pursuit tracking phase (i.e., following the flight path), and concluding with the aiming phase (i.e., orienting the body to make contact with the projectile)."[116]

[115] Chapter 2
[116] Vickers, J.; The Quiet Eye; p. 102

Chapter 8 – The Game Action

1. Perception
2. Technique and the scheme of Gabler & Schrade

The Game Idea in ball trajectories is only concerned about two things. The producing of chains of ball trajectories and to prevent the opponent from doing that. The Game Idea is the full description of the game of tennis. There are no possibilities or perspectives left to view it from a different angle. The Game Idea embeds all earlier descriptions of the game.

The Game Action is the elaboration of the Game Idea. It describes all the actions the Game Idea needs. It gives a clearly defined list of actions which must be executed. The Game Action rejects all actions which aren't mentioned. They reinforce *self-1* and may never be emphasized structurally.

The lengthening of chains and preventing the opponent to do so are appointed separately in the Actual Tennis Action and the Tactical Tennis Action. That could give the impression that they are separate and/or linear events. That is absolutely not the case. They are continuously working and at the same time occupied with the incoming ball trajectory and the outgoing ball trajectory during one rally. So in match situations they have to be merged. In match situations the whole Game Action must be applied and not separate parts of it. Parts can be trained separately.
The Game Action needs no further explanation. The merging of the Actual Tennis Action and the Tactical Tennis Action doesn't add any extra value.

The Game Action is the ultimate explanation of the game and not the ultimate explanation of playing the game. The Game Action is not interested at all how the game is played. The Game Based Approach is first about the explanation of the game and then how it is executed. *The game* is played with technique. In a formula this becomes: GBA = Te x (GA). The Game Action is the leading and dominant factor. The technique (Te) must be adapted to *the game*.

The appointing of the technique outside of the Game Action clears the way for training the Game Idea without the technique[117]. The Tactical Tennis Action can be fully trained off court with MindTennis. This will cause a revolution in training regimes. The Actual Tennis Action can be fully trained at the court independently. Both tennis actions are complete (sub)systems themselves.

1. Perception

If one looks at the many perception processes involved in the Game Action one can conclude in retro-

[117] See chapter 12 GBA – consequences for daily training sessions - MindTennis

spect that the perception was allocated a too little role in the *old* tennis action. The quantity of perception processes dominate the whole process. The perception even runs across a cycle of a chain of ball trajectories.

"The human performer is effectively a moving platform (trunk) with manipulative devices (arms and legs) operating with a 'smart' processor (the brain and central nervous system). Some 30% of the processor is dedicated to visual information (Hubel 1988). Humans conduct their daily activities in a dynamic, cluttered environment within which survival depends heavily on visually processed information. If vision is disrupted or somehow impaired, even the simplest of tasks becomes laborious. In sport, where participants and objects frequently move on complex and rapid trajectories, the need for efficient vision is paramount."[118]

Even before the outgoing ball trajectory^{-1} (OBT^{-1}) is hit the perception is making images of incoming ball trajectories based on the perception of the outcome of that OTB^{-1}. The perception of the ball in relation to its ball trajectory casts its shadow forward to future shapes of the ball trajectories continuously. Actual perception processes have to check these latent images and to adjust these images where needed in an ongoing mutual process. All this perceptual checking back and forth only stops when the chain stops and the rally is over.
The perception also concerns the most complex perception processes. The catching and throwing tasks on their own are in the field of Motoric Movement Actions already quite difficult actions qua perception processes. In tennis it is even a combined task that has to be executed. Tennis can be subscribed to the toughest category of Motoric Movement Actions.
The Decision (D), Execution (E) and Feedback (F) phases of the *old* tennis action can keep their linear status but the Tactical Tennis Action embeds all the perception processes of the old tennis action and the four basic tactical principles. That makes it that the tennis action has to be judged as a complex system from now on. In that way anticipation is fully integrated. The Tactical Tennis Action with the ball trajectory as a premise has embedded it all.
In the Game Action the visual perception is appointed. Of course there is perception with other senses. But however they can attribute they are never dominant. In tennis they can be treated in the traditional way. They don't need further appointment.

"By limiting our analysis to visual perception, it should be clearly understood that we do not mean to imply that non-visual sources of information are irrelevant or unnecessary for athletic performance. ……..It has been known for some time that most of the information that we receive and use to plan our actions comes from the visual system. Information from the visual system tends to dominate the inputs from the other sensory systems. Cutting (1986) has pointed out that 'it is largely through vision that we know our environment and our physical place within it' (p. 3). Schmidt (1988) has called it the 'most critical receptor system for supplying information about the movement of objects in the outside world'"[119]

2. Technique and the scheme of Gabler & Schrade

The appointing of the Game Idea in this Game Action has consequences for the scheme of Gabler & Schrade[120]. The scheme of Gabler & Schrade is an important part of the curriculum in educating tennis coaches of the Royal Dutch Lawn Tennis Union (KNLTB).

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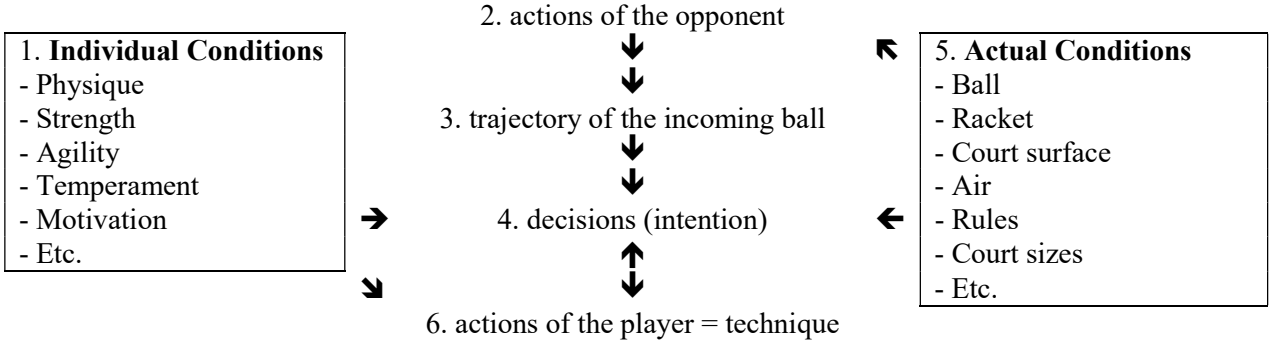
[118] Williams, A.M., Davids,K., Garrett, J.; Visual Perception and Action in Sport; p.61
[119] Williams, A.M., Davids,K., Garrett, J.; Visual Perception and Action in Sport; p. 147
[120] KNLTB curriculum A; p. 27 and p. 142



Scheme of Gabler & Schrade

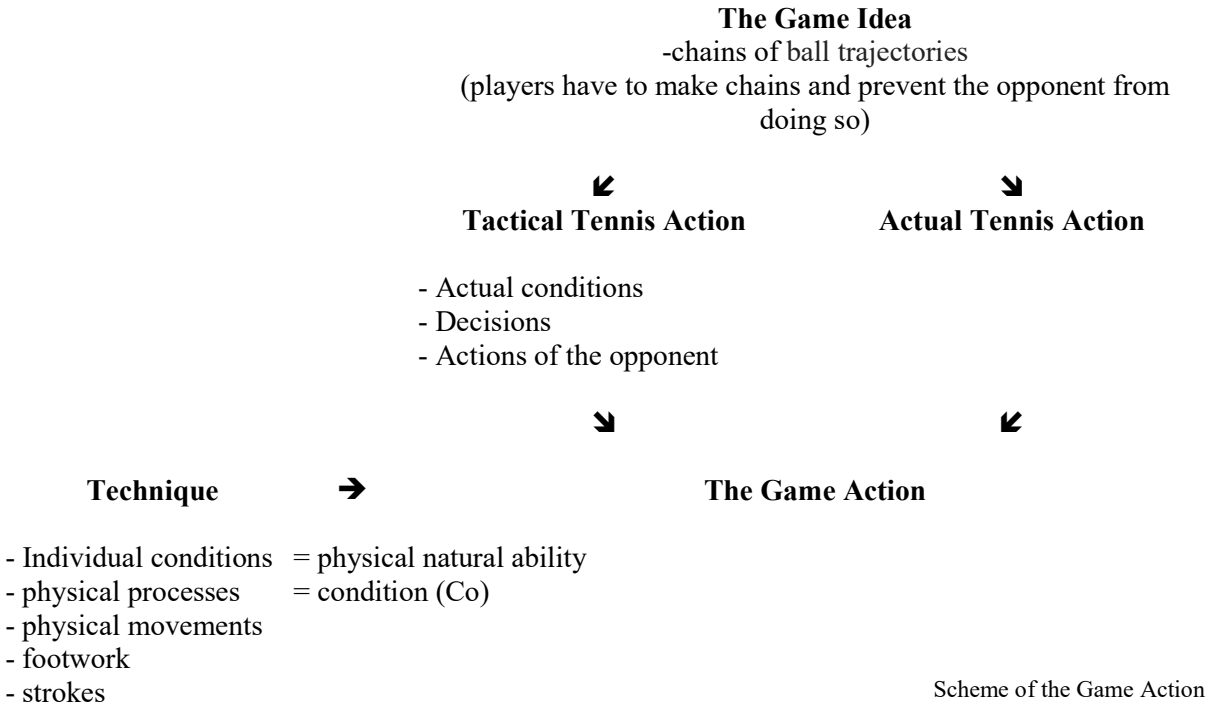
"A modern approach is to regard a technique as a goal oriented solution for a certain (tennis) problem.

***Technique** is the scheme of complex conditions which the separate techniques have to meet as possible solutions to the under (2) + (3) + (4) + (5) stated movement tasks in relation to the individual conditions (1).*

Factor 1 already shows that it is not possible to execute technique in one way by every player.

This fits seamless to our education doctrine that technique is individual and must be seen as a means to fulfil intentions."

Again one can notice the linear character of the scheme. There are a few mutual relations but they are appointed just marginally. In retrospect the ancillary role of the ball trajectory is the biggest *mistake* in this scheme. It is hardly appointed in any way.
However, the scheme was a nice try to describe the game. Most parts will have to stay and cannot be rejected. They have to be appointed in future schemes. In the schema of the Game Action it would look like this. Of course it all revolves around the Game Idea in ball trajectories.



Scheme of the Game Action

The individual conditions will be covered by the technique. The technical possibilities of the opponent are assessed in the Tactical Tennis Action. The cognitive basis of your game plan must contain an opponent specific assessment. The actual conditions are a part of the perception within the Tactical Tennis Action.

Chapter 9 - The Game Based Approach (GBA)

1. Introduction
2. The *Technique Approach* or *Model Approach*
3. The *Player Based Approach*
4. The *Game Based Approach*

1. Introduction

The real Game Based Approach is the approach which explains all Motoric Movement Actions in tennis out of the game. This explanation has its roots in the Game Idea. The Game Action explains tennis as a complex system in one model out of the perspective of the ball. The model is complete and complies to all demands of a complex system. The model is so universal that even all Motoric Movement Actions you can imagine follow it. The model holds its ground under all circumstances and is close to the truth. There for the model must form the compulsory base for all hierarchical lower facts.

The Game Action appoints the whole Game Idea without interference of technique. It is the full explanation of the game. The Game Based Approach also has to appoint the execution of the Movement Action. So the Game Based Approach also has to appoint the playing of the game. That is very easy and can be done in a simple way. The game is played with technique. That is all. It sounds simple but this is the essence in six small words.
In a formula it looks like this: GBA = Te x (GA). The technique (Te) is attached completely outside of the Game Action and is the servant to the Game Action. The technique is irrevocably fixed to the Game Action. This is compliant with all Motoric Movement Actions which are executed[121]. For all Motoric Movement Actions the universal formula is MMA = MM x (MA). In games/sports this can be specified to the first formula. There are no differences other than linguistic ones.

Technique must also be appointed as a complex system[122] however the bio mechanist elite still appoints it in a linear way. I have found multiple complex models in most strokes which explain technique completely. To describe these models substantially is beyond the purpose of this book. And besides that it is very hard to explain complex technique models on paper. It would immensely exceed the size of the book in front of you now. In this book the focus is on Game Idea. In chapter thirteen I will just give a brief introduction to technique models and an explanation in what way elite players adapted their strokes to the Game Idea[123].

In this chapter I will outline a short historic image of the development of the Game Idea in tennis education. In my opinion every teacher thought he was serving the game in the best possible way. After all every approach delivered champions. Now with the complete Game Idea at hand it is a good thing to appoint all approaches in retrospect. The position of the real Game Based Approach will become clearer and the other approaches get there right historical perspective. From now on the *old* Game Based Approach must be called the Player Based Approach. "Watch The Ball Trajectory!" is about the real Game Based Approach.

[121] N.J. Mol; *Caught In A Line* – The Motoric Movement Action
[122] Chapter 13.2
[123] Chapter 13.3

2. The *Technique Approach* or *Model Approach*

a. Description

In the *Technique Approach* or *Model Approach* the focus is only on the technique. The premise is that there exists one perfect technique in every stroke with which you can control every game situation.

"Traditional tennis coaching was based on the priority of conforming students to these models (in other words, treating tennis like a closed skill sport). The typical lesson consisted of a coach standing at mid-court delivering a soft feed to a student. Once the model stroke was reasonably stable, the coach sent the player back into the "real world", expecting the player to successfully use the carefully-polished stroke in a live rally or match play situation.
The typical result was the stroke quickly breaking down. Why? Because the player was not taught how to adapt it to real play situations. If the player returned to the coach for further work, the cycle was typically repeated."[124]

"The Technique Teaching Approach.
The emphasis in this model is on students acquiring technical skills for game play. The structure of the technique approach is as follows (Turner & Martinek, 1999): 1. Introductory activity: Explanation of the skill. 2. Demonstration of the skill. 3. Practice: Structured tennis drills designed to enhance skill acquisition. They are usually static drills, at first, before students attempt more dynamic practice tasks. 4. Feedback: During each class the teacher or coach provides feedback on technique to the students. 5. Game play occurs at the culmination of each lesson and the teacher provides corrective-skill feedback at this time. As an example, the following skills can be covered in a 10 lesson unit: footwork, forehand, backhand, lob, smash, forehand and backhand volley, drop shot and serve. Players could also participate in singles games (half court or full court) at the end of each lesson for the initial eight classes. For the final 2 lessons they could play doubles games at the end of their classes."[125]

"The "Model" approach.
The traditional way tennis has been taught is with a "Model" approach. The philosophy of this approach was simple: Teach the best technical model for each stroke to help the students play the best tennis possible. Motor skills were the priority.
The methodology of the approach was also simple: Demonstrate the model stroke and then have the students reproduce the model stroke. In lessons, students were immediately introduced to an 'idealized' version of a stroke (e.g. the forehand). Learning the 'proper' grip, preparation, swing, and follow-through, were all preconditions to playing tennis. These were typically learned in a controlled environment with the coach lightly feeding the ball to the student. Technique was the main goal, tactics were presented later, once a player learned how to hit the ball."[126]

b. Time line

"For over a century, physical education teachers and coaches have been using this model because it has intuitive appeal."[127]

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[124] http://www.acecoach.com/main/spage/openskill/
[125] The Games for Understanding (GFU) Teaching Approach in Tennis; A. Turner, M. Crespo, D. Miley; ITF Coaching & Sport Science Review Issue 26 (2002)
[126] Wheelchair Tennis Coaching Manual; W. Elderton; http://newbrunswick.tenniscanada.com/sites/default2/files/Wheelchair-Tennis-Coaching-Manual.pdf
[127] The Games for Understanding (GFU) Teaching Approach in Tennis; A. Turner, M. Crespo, D. Miley; ITF Coaching & Sport Science Review Issue 26 (2002)

At especially American forums the debate is still all about the perfect technique. There are a lot of discussions among players but a lot of teachers mingle in as well. It has been the traditional approach and it will take a long time for this approach to disappear.
It is important that key persons and key organisations appoint the truth and reject invalid approaches. If methods are rejected there must be alternatives available. The *Play & Stay* tennis programs for kids based on the old Game Based Approach are there since medio 2000. In Holland they really became a success just a few years ago.

c. Minor aspects

Relatively it takes a lot of time before a player masters the perfect technique and can start to play the game.

d. Conclusions

If one compares the Game Action to the Technique/Model Approach the conclusion must be that the new insights of the Game Action also leave no room for these approaches. Although the Game Action shows that the technique is much more limited than the old Game Based Approach suggested. The chain must be lengthened with one unique outgoing ball trajectory to one unique incoming ball trajectory. In this view tennis is not an open skill sport anymore. Still there are no direct demands to the technique itself. But in an indirect way the technique has to comply with a lot of compulsory demands.

3. The *Player Based Approach*

The *old* Game Based Approach must be renamed into the Player Based Approach. At least if one wants to call a spade a spade. The name Game Based Approach was invented as a counterpart of the Technique/Model Approach.

"The Game-based approach uses the word "game" to emphasize the idea of playing rather than reproducing a technical model. The idea behind the approach is that since tennis is a game, students need to learn how to play. The fun of playing is why people take up the sport."[128]

The old Game Based Approach is also known as *The Actions Method.*

a. Description

"The Games-Based Approach (GBA) focuses on the tactical problems of game play. The structure of the approach can be summarised as follows (Turner, Allison & Pissanos, 2001): 1. Introduction: A mini game (modified tennis game) is introduced initially at the start of each lesson along with a description of the basic rules of this game. • The goal is to encourage tactical thinking (what to do in specific game situations). • The rules provide shape to the game and determine the range of tactics and skills that are required for successful performance. • The game is used as a point of reference to assist players in learning to make appropriate decisions in light of tactical awareness. 2. Selection of tactical responses: Students learn how to match game conditions with the selection of appropriate tactical responses. • The teacher and students will investigate the tactical problem and potential solu-

[128] Wheelchair Tennis Coaching Manual; W. Elderton

tions. 3. Skill practices: The students will recognise the need for learning specific skills via game-related practices to solve their tactical problems. • Skills, like volleying and smashing, are subsequently taught once students see the need for these in the context of their games. • Skillful performance is thus viewed in the context of the learner and the game. 4. Game play: Following game related practices, students will return to game play to apply their skills."[129]

"The idea behind the approach is that since tennis is a game, students need to learn how to play. The fun of playing is why people take up the sport. The philosophy of the approach is that playing is not just a technical challenge but a tactical one as well. The tactics of the game dictate the technique of the game. In other words, one needs to know what to do before being taught how to do it. Cognitive skills become equal in priority to motor skills."[130]

b. Time line

"The official tennis coaching methodology in Canada is called, "The Actions method" ("Actions" for short). Actions was inspired from work done in the 1970's by Swiss Coach M. Jean Brechbühl, author of "La Maîtrise du tennis" (Payot, 1974). Brechbuhl applied an innovative pedagogical approach to tennis. His approach provided progressive problem solving learning activities to guide the development of tennis skills. In 1980, after using this approach for a few years, Louis Cayer, from Canada, added a tactical-technical framework that could be applied to high performance players as well as beginners. The Actions Method was introduced in the Canadian certification system in 1982 and became Canada's official tennis teaching method in 1988. It was also presented at the 1987 ITF World-wide Coaches conference in Majorca, Spain."
"The GBA has found considerable support among physical education practitioners in Europe and the United States (Griffin, Mitchell & Oslin, 1997; Turner, 2001). Governing bodies, in various sports, are also beginning to recognise the potential of a GBA. The International Tennis Federation (ITF) has adopted a similar GBA to introduce young players to tennis via mini-tennis. The importance of understanding the precise benefits of a GBA are highlighted by the ITF School Tennis Initiative (STI) to introduce minitennis to as many elementary school students as possible each year across the world. Similarly to reinforce the effectiveness and appropriateness of the GBA as a vehicle for the introduction of tennis, the ITF is actively supporting GBA research efforts."[131]

It is only until the year 2000 that the Game Based Approach is implemented in a structural way.

"In recent years researchers have examined the efficacy of a GBA to sports instruction. However, there has been little tennis specific research conducted with the GBA. Tennis teachers and coaches need to be provided with research-based information pertaining to the effectiveness of the GBA and Technique Approach in order that they can provide the optimal tennis learning experiences for their students."
"Tennis has been changing a lot during the last 15-20 years but for many decades teaching methods were behind general development of the game. Tennis started to lose the battle to other, especially "new" or more "elite" sports and other leisure activities. One of the reasons was that the traditional method of teaching tennis was focused on a technique or production of the strokes (Crespo 1999) without understanding real character of the game and approach has not been changing for many years."[132]

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[129] The Games for Understanding (GFU) Teaching Approach in Tennis; A. Turner, M. Crespo, D. Miley
[130] Wheelchair Tennis Coaching Manual; W. Elderton
[131] The Games for Understanding (GFU) Teaching Approach in Tennis; A. Turner, M. Crespo, D. Miley
[132] Review of modern teaching methods for tennis; P. Unierzyski, M. Crespo (2007) http://www.cafyd.com/REVISTA/00701.pdf

Then multiple articles appear in the *ITF – Coaching & Sport Science Review* editions and slowly tennis methods for children are introduced. Play & Stay in the form of *Tenniskids* is introduced in Holland. These methods got really rooted just a few years ago after the ITF made the decision that official matches must be played with the correct court sizes.

c. Minor aspects

The teaching model in the current education programs of the KNLTB is abandoned by most teachers once they passed their final exam. They don't experience the model as the truth. I have seen up to 200 teachers in daily lessons and I discovered only one teacher who implemented the whole model. Most - of them probably return to their old habits. When the Game Based Approach passes in forum topics then people don't buy it. Let's just say that the *Player Based Approach* is not really convincing. Maybe it is because the *old* Game Based Approach appointed parts in a wrong and incomplete way. All the loose ends didn't make it convincing. If old structures must change there is an old adagium. If it is not completely good it is no good at all. Although parts were much better than the old situation.

d. Conclusions

All actions within the *old* Game Based Approach are aimed at getting the player to play in a better way.

> *"The Tennis 10's system is very conducive to using a Game-based Approach to coaching. A simple definition of GBA is: "Get players to play then, help them to learn to play better"."*[133]

It contains the premise that tennis is an open skill sport but it adds nothing to the Game Idea. However there is a lot of *player centred* appointing. And that is a very good thing. The player needs to find his own technique to play the game of tennis. In all methods to follow this must be maintained as one of the key points.
It is justified to rename the *old* Game Based Approach into the Player Based Approach.

4. The *Game Based Approach*

The new Game Based Approach is the full description of the game. It appoints all actions in a complete enumeration. Initially it is not a tennis method and is not meant to help a player. It must serve as the premise for all actions and notions in tennis. So all tennis methods must comply with this premise.

Now with the new Game Based Approach one can in retrospect state that the predominant facts to help a player have never been appointed and that tennis can't be explained in a linear way. Tennis is much too complex for such a description. What we instinctively felt for a long time is finally been proven. That is why it was called an art. Because nobody ever understood it completely.

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[133] ITF - Coaching & Sport Science Review Issue 51, August 2010

a. Four distinctive foundations

I will discuss the new Game Based Approach according to the following components.

"Actions is based on 4 distinctive foundations that set it apart from many of the other coaching methodologies found around the world:

• Learner-Centred: The focus of the coach in Actions is based on asking the question, "What does the student need to learn". This can lead a Coach down a radically different path than asking "What do I need to teach".
• Global (sometimes called 'Holistic': Actions takes into consideration that players are an integration of Physical, Tactical, Technical, and Psychological components. Tennis instruction should also integrate all these components.
• Open Skill: Since tennis requires technical skills that must adapt to different situations, tennis skills are classified as 'open' skills. The process of coaching open skills differs from coaching skills in 'closed' skill sports like gymnastics, diving, etc.
• Game-based: Learning skills in a tactical framework is called the Game-based approach (see next section for more details). Actions is based on the philosophy of learning tennis in Game-based situations.[134]*"*

Ad.1: *Learner-Centred*

The new Game Based Approach is not a learning method but just answers the question what a player has to execute to play the game out of the Game Idea. The new Game Based Approach explains all actions out of the perspective of the ball and embeds the perspective of the player by doing so.

Ad. 2: *Global*

More than in a holistic way the new Game Based Approach must be viewed as a complex system. It integrates all elements. The appointing as a complex system also has the consequence that this classical foursome comes to an end. They are part of a linear thinking approach which has no place in the new assumptions.

"The concept of integrated training for tennis states that the traditional distinction between technique, tactics, conditioning, and mentality is more artificial than real."[135]

Ad. 3: *Open Skill*

Technique is placed outside of the Game Action. The game is played with technique. Technique and the Game Action in tennis are complex systems. They are subsystems of the Game Based Approach. There for tennis can be viewed no different than an open skill sport.
It is important to notice that although the game of tennis is an open skill sport the Game Action always leads to the production of one specific outgoing ball trajectory to one specific incoming ball trajectory. A player is only able to make one trajectory. And he is forced to make one trajectory. So if the tactical considerations are over the game is not that open anymore. At that moment only two ball trajectories

[134] Wheelchair Tennis Coaching Manual; W. Elderton
[135] Miguel Crespo; J Med Sci Tennis 2009; "Tennis Coaching in the Era of Dynamic Systems" (p. 24)

exist in the whole wide world. And that is always the next outgoing ball trajectory to the next incoming ball trajectory.

Ad. 4: *Game-based*

The new Game Based Approach appoints all the actions a player has to fulfil. If methods comply with this limited list than they are *game-based*.
Within the nowadays *old* Game Based Approach education programs of the ITF students are taught the five main game situations (MGS). 1. Baseline 2. Service 3. Return on service 4. Approach and net play 5. Playing against the net player. These main game situations are not appointed by the Game Action. The Game Action only regards the lengthening of the chain and the prevention of the opponent fulfilling that task. Position, game situation or game intention is not important. On the other hand the five main game situations do not contradict the Game Action. So they don't have to be rejected and are allowed to exist as a part of a tennis method.

b. The Game Based Approach and technique

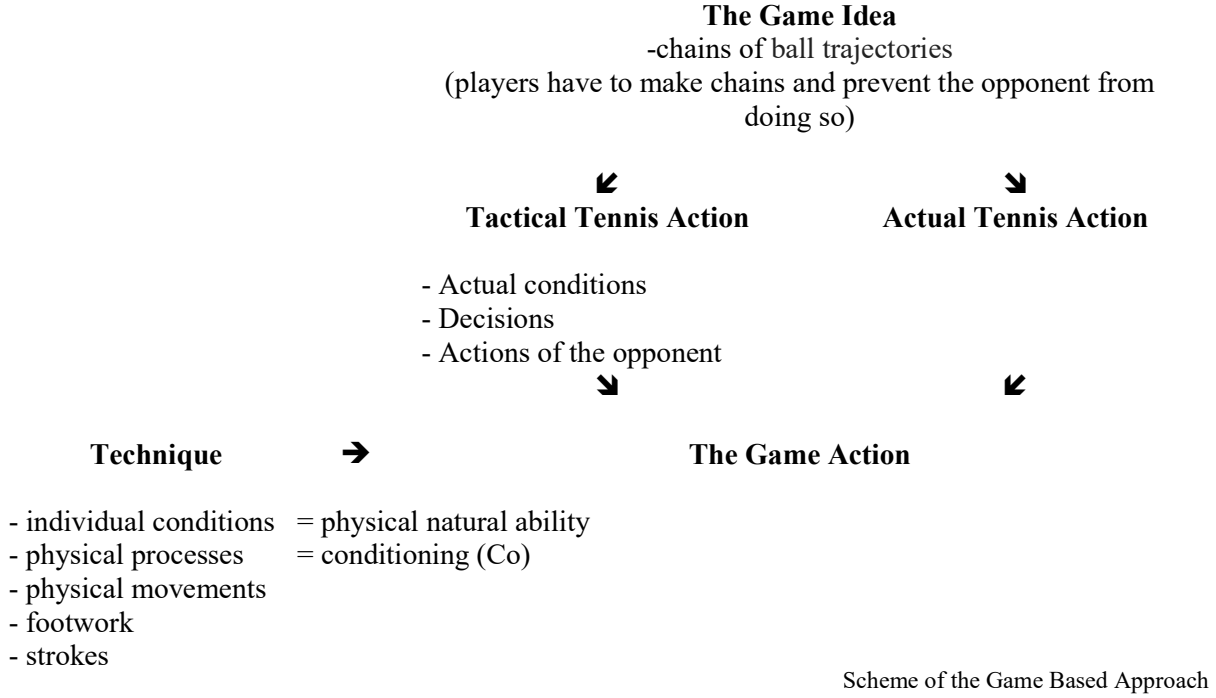
The Game Based Approach must cover the whole game. The Game Action is only concerned about the Game Idea and not about game play. Of course the technique is essential for playing the game. The exclusion of the technique in the elaboration of the Game Idea is to define the hierarchical order. The technique serves the Game Idea.

In the full Game Based Approach this position leads to a lot of clarity. Where they used to appoint technique as a dominant factor it now becomes clear that the Game Idea is dominant over all other factors.
Within the Game Idea ball trajectories will not often come to you. To lengthen a chain you will have to do more than only move your hitting arm. And that is also more than moving your legs. The definition of the technique within the Game Idea covers all movements and processes that have to be made to lengthen the chain. Of course hitting technique and footwork remain important parts but it is important that it is no longer viewed as a linear process. Technique is a complex system in itself and a complex subsystem of the Game Based Approach.

One can still view technique as an open skill. The Game Idea doesn't make any demands. The player is totally free to use any technique as long as he will be able to make the specific outgoing ball trajectory. How it is done is not an interesting question for the Game Action.
However the Game Idea gives compelling advice. Because there is a need to lengthen chains continuously it is wise to use a technique which can be used safely and for a long time. That wisdom was known for quite some time.

c. Categorisations

Tennis is traditionally divided in tactics (Ta), technique (Te), conditioning (Co) and mental (Me). They are formulated as four separate parts and in a linear way. They will continue to exist but the new Game Based Approach has to make a few critical remarks. The dividing in four parts leaves no room for the Actual Tennis Action. That is a big omission.



Scheme of the Game Based Approach

Ad. 1: Tactics

Tactics completely belong to the Tactical Tennis Action. The Tactical Tennis Action concerns many perception processes. They are mental (Me) processes by nature. Tactics not only cover all tactical actions on court but also cover all knowledge stored in the cognitive basis. They are mental processes too.

Ad. 2: Technique and Conditioning

Within the full Game Based Approach technique is considered to be a complex system. It covers all processes to execute the Game Action when the game is actually played. In that way conditioning is a complete part of technique although it is complex (sub)system in itself. Together with 1. individual conditions, 2. physical movements, 3. footwork, and 4. strokes, it shapes the whole complex (sub)system Technique. So conditioning is covered by the term physical processes. It also covers gained agility through exercise. This makes a contrast with agility which is genetically given to a player (individual conditions).

Ad.3: Mental

If all perception processes would be ranked as mental that part would substantially increase in size. However the perception processes in the new Game Based Approach tell the player what actions need to be fulfilled very clearly. They are very clear actual processes.
There are too many mental methods. One of the latest methods tell players to have *friendly eyes*. The full Game Based Approach doesn't take any interest in the condition of the eyes of a player. As long as he looks for relevant information during the Game Action and compares that with a reference image.
These kind of mental methods can be a help in becoming a better person but it is not allowed anymore to connect them to the Game Action in any way. In retrospect the conclusion will be that they existed because of the incompetence to appoint the Game Action in the right way.

Chapter 10 – The GBA ~ consequences for daily practise ~ *Ball Trajectories*

1. The x-axis and y-axis of ball trajectories
2. The elevation angle
3. Tempo
4. Ball trajectory shapes
5. Dualism in ball trajectories
6. Ball trajectory models
7. Scoring patterns
8. Reference ball trajectories
9. Ball trajectories do not lie
10. Ball trajectories come towards you or they do not come towards you
11. Almost perfect ball trajectories

The ball has a mutual relationship with its ball trajectory. The ball shapes the ball trajectory but also has to follow the during the Initial Phase established shape. A ball trajectory is the result of all the separate successive positions of the ball. A photo of only one ball in that ball trajectory only says something about the place of that ball. If one would only look in that way to all the separate ball positions than the receiving information would only be complemented with every new position of the ball. The consequence of such a view would be that a player wouldn't be able to anticipate and would have to structurally look at the ball. That this is not the case we already can experience in the direction anticipation of beginners. Even beginners react in an early phase if they must perform a backhand or a forehand.

Image: A photo of one ball in a ball trajectory only says something about the place of the ball

A player needs to know everything about ball trajectories. It is the action trajectory with which you play the game. The cognitive base requires a huge reservoir of knowledge about these lines. The cognitive basis must give the answers of the *how* and *why* of all existing ball trajectories. This information must be complemented with abstract knowledge of ball trajectories. The Tactical Tennis Action demands knowledge about the intrinsic value of the incoming ball trajectory and the outcome of the outgoing ball trajectory in relation to the position of the opponent. The Actual Tennis Action demands to connect many different incoming ball trajectories to many different outgoing ball trajectories. The player must be able to execute it all with technique.

Ball trajectories which will be taught must comply to the premise that they go over the net and that they touch the opponent's court if the opponent makes no attempt to touch it first. A ball trajectory is shaped during the Initial Phase. A player solely makes the whole ball trajectory in that first phase and there for should direct his perception only to that area. A player must not be occupied by hitting over the net or to a goal area. That is detrimental to the quality of the whole process and considering the premise it is not necessary. A player must be occupied only with how the actual shape of the outgoing ball trajectory after the bounce will be related to the opponent. According to the Game Idea the game is situated there and nowhere else. If the Game Idea coincides with the actual actions to be executed *flow* and *playing in the zone* will occur.

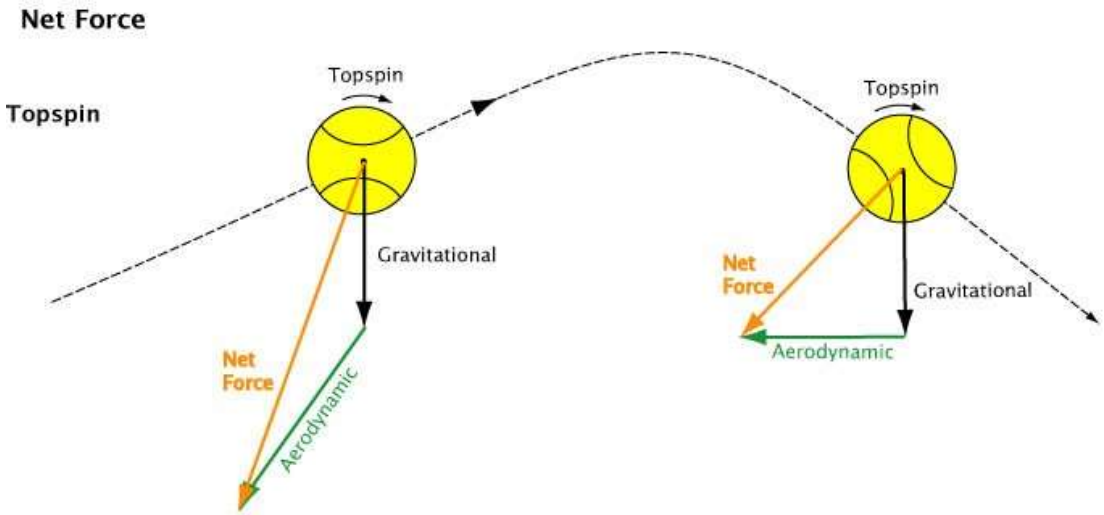


Image: There is a lot of physics research concerning ball behaviour. There is no research with practical relevance to the Game Action.

In this chapter I will discuss the substantial part of ball trajectories. I will focus on practical information. There are a lot of scientific articles addressing ball behavior[136]. A coach should know it is there but in relation to actual helping a player he can neglect it. A player appears to understand the bounce behaviour without these articles.

1. The x-axis and y-axis of ball trajectories

[136] F.e.: Bounce of a spinning ball near normal incidence, R. Cross; Ball Trajectories Factors Influencing the Flight of the Ball, R. Cross; http://twu.tennis-warehouse.com/learning_center/aerodynamics2.php

A ball trajectory has a 3-d shape. For practical reasons this shape can be reduced to 2-d. The majority of existing ball trajectories are shaped by mainly the x-axis and the y-axis. Side spin shots (*banana* shots) where a third axis has a major influence to the ball trajectories are a rare phenomenon.

Image: Ball trajectories in 2-d; the x-axis is dominant over the y-axis

The x-axis gives the shape to the horizontal part of the ball trajectory. The x-axis is influenced by the horizontal powers which are transferred during the Initial Phase from the racket to the ball. The x-axis is *the drive*, the *motor* of a ball trajectory. In the still ongoing era of power tennis a ball trajectory needs to have a big x-axis component. It is the dominant factor in round ball trajectories during the building phase[137] in a rally.

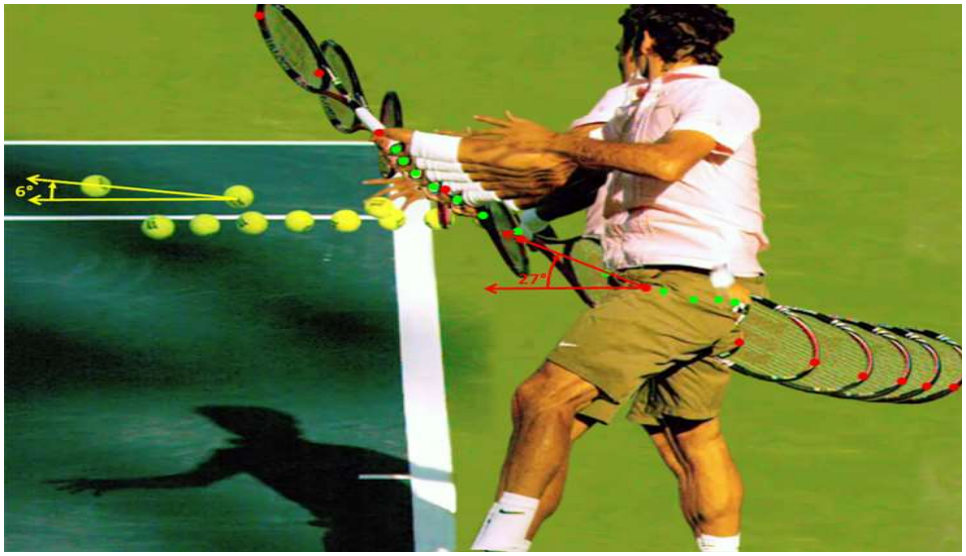


Image: The shaping of the x- and the y-axis during the Initial Phase

A common mistake in gameplay of starting adult male tennis players (level 7-9 Dutch standard) is that they add spin without penetrating power. They often produce huge blows which result in massive spin ball trajectories. They also have to learn to emphasize the x-axis during the Initial Phase.
The y-axis gives the shape to the vertical part of the ball trajectory. The y-axis is influenced by the vertical powers which are transferred during the Initial Phase from the racket to the ball. The elevation angle plays a crucial role in there. The y-axis is mainly constructed by the hand and the wrist.

The x-axis can be considered as the big dumb dominating driving force. The y-axis can be considered the minor artistic influence which is crucial for the quality.

[137] Chapter 1.6 Game Intentions

2. The elevation angle

The shape of the ball trajectory is mainly caused by the angle of departure[138] of a ball trajectory. The elevation angle is the angle the racket face makes towards the ball during the Initial Phase in the main phase of the swing. The elevation angle is the main influence to the y-axis of a ball trajectory.

The Initial Phase of the ball trajectory also shows an angle to the horizontal plane. Both angles have a set correlation with each other.

Image: The elevation angle; *the angle of the racket head towards the ball during the main phase of the swing*

3. Tempo

The appointing of the tempo is equal to volleyball. Volleyball also knows a first tempo and a second tempo attack[139].

The word tempo in relation to ball trajectory shape has to do with the place of the incoming ball trajectory where the outgoing ball trajectory is created. The ultimate tempo is situated in an intersection point before the bounce of a ball trajectory. However there is no need to appoint this tempo. Though it is important to appoint the tempo moments after the bounce. The 1st tempo in a groundstroke is situated in the segment of a ball trajectory from the ground up to the highest point. The 2nd tempo is situated in the downward segment of the ball trajectory after the highest point of the ball.

Before the highest point is reached the upward forces are dominant over the downward forces. The ball in that segment has a tendency to rise. When you intercept a ball in that segment it will press into your racket. That is why the 1st tempo is extremely fit to create intersection points for flatter outgoing ball trajectories. At that point the flatter angle of elevation also corresponds with the incoming shape and a ball intercepted there is always closer to the net.

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[138] Chapter 10.2

[139] http://opensourcevolleyball.blogspot.nl/2015/11/volleyball-basics-offensive-tempo.html and https://www.youtube.com/watch?v=XexM9WtavLc&index=19&list=LLC0Lt4R8EuKPPvPIMB7tqCQ

The highest point after the bounce is the transition moment from the 1st to the 2nd tempo. At this point the upward forces are equal to the downward forces. Within one ball trajectory the highest point gives most opportunities to make downward ball trajectories.

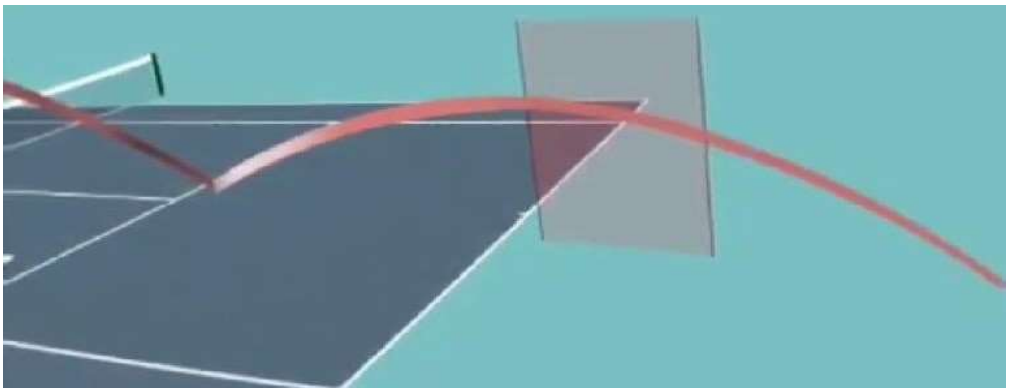

Image: round ball trajectories after the bounce; the marked segment shows the first part of the 2nd tempo; elite players prefer this segment to create intersection points for round outgoing ball trajectories

After the highest point the downward forces become more dominant. In the end a ball trajectory will always bend down due to gravity forces. The shape of the trajectory is a line going downward. A ball in this phase will move further from the net and will no longer press upwards into the racket.
This part is extremely fit for producing round outgoing ball trajectories. An *under and over* technique matches the shape of the ball trajectory in that phase perfectly.

Elite players prefer to hit round ball trajectories especially from an intersection point just after the highest point is reached. They often take the first descending segment of the line the ball is making during the 2nd tempo[140].

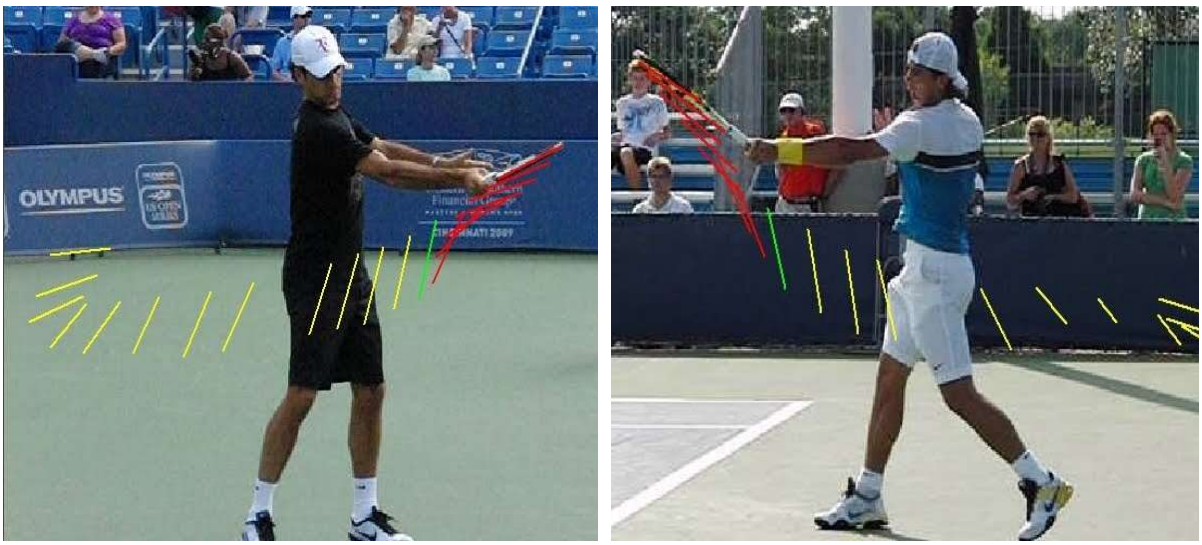

Image: *Under and over* technique; The yellow lines come from under to the intersection point (green line), then the racket head *travels* over the ball in red during the Initial Phase.

[140] For example Simon-Monfils; *the longest rally ever?*: https://www.youtube.com/watch?v=rLDm254jtZA

The 2nd tempo is situated in a ball trajectory from the highest point till just before the second bounce. For beginners there are many possibilities to hit the ball when they use a line for the racket head which is the reverse image of the descending line of the ball trajectory. Many beginning adult players play matches mainly out of the 2nd tempo. Children used to mainly play in the same style. Luckily now with the new formats of court sizes there has come an end to that.

In doubles there can be made a lot of progress if players realise that the 2nd tempo is stretched to just before the second bounce. At beginning competitive levels 7-9 (Dutch rating system) players just do not react to ball trajectories which can be reached. Intersection points far in the 2nd tempo don't give offensive outgoing ball trajectories but give opportunities to let the opponent hit one more ball. Defensive play in doubles is an art. The use of the 2nd tempo can especially be seen at the highest levels. In doubles power is not the main factor in *building* a rally. Players mainly work towards weak incoming ball trajectories out of late 2nd tempo intersection points. This can very well be seen in badminton as well.

4. Ball trajectory shapes

In tennis one can distinguish the following ball trajectory shapes:

a. Round ball trajectory shapes

The DemoClip contains only round ball trajectory shapes. They are hit with a hitting technique from under the ball upwards. So there is always a positive elevation angle and the ball will always rise during the Initial Phase. Sometimes only a few degrees but always rising.
So the progress of the first part of the ball trajectory will be round and will not experience any hindrance of the net. That is why the success rates of this type of ball trajectories are high. However the ball trajectory after the bounce will also be round and this fact will give an opponent lots of opportunities to do something with the ball. The ball will relatively stay in the air for a long time. Rates towards building (B) or scoring (S) are there for low. Round ball trajectories are chosen out of the idea of a high execution percentage and maintaining the equality in tempo till there is a possibility to gain the tempo.
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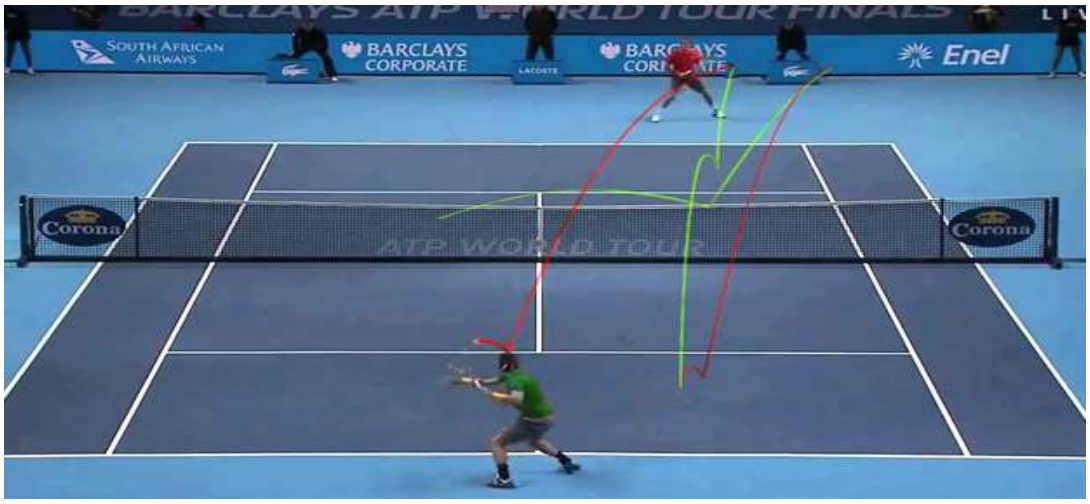
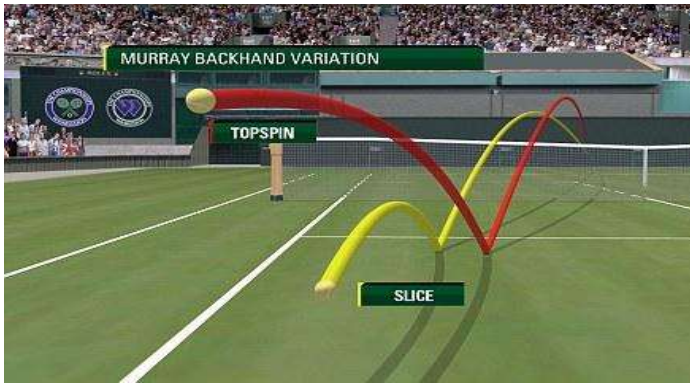
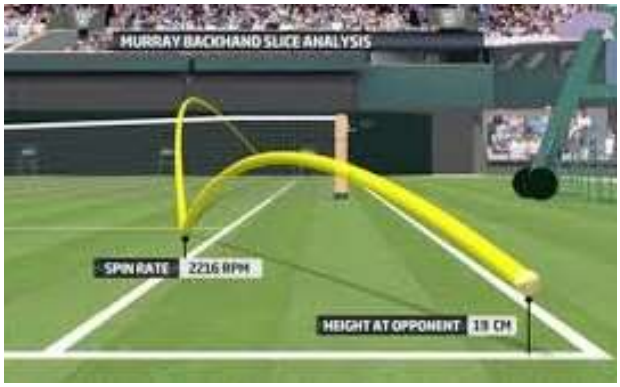


Image: The DemoClip only contains round ball trajectories

These round shapes can safely be executed with a maximum of power. We are still in the era of power tennis. Players want to overpower their opponents with more ball trajectory defining factors (BTDF) [141]. With the goal to gain a little advantage in tempo. Round ball trajectories give players the possibility to do that safely. The disadvantage of an incoming ball trajectory with high ball speed is that the ball trajectory will often come towards the opponent.
Round shapes in ball trajectories can also be created by *slice* hits. It doesn't belong to the majority of shots played in pro tennis. This ball trajectory has much lower pace than the power ball trajectories. Often they are born out of a forced low contact point. A disadvantage for the opponent is exactly that lower pace. The ball trajectory doesn't hurt you but you can't develop a lot either. It gives you low intersection points and you have to generate pace yourself. This ball trajectory is often not coming towards you.





Images: examples of round *slice* ball trajectories of Andy Murray. Noteworthy is the ball staying low after the bounce and the low velocity of the ball.

b. Straight ball trajectory shapes

Straight ball trajectory shapes are often constructed due to underspin (slice). Players experience these ball trajectories as straight lines. Compared to round ball trajectories these ball trajectories have relative low ball speeds and they have a tendency to skid from the court. The ball trajectory is approaching low and straight and produces a low incoming angle of the ball trajectory towards the court. The low incoming angle produces a low outgoing angle and that takes care of good conservation of the ball speed before the bounce. The advantage for the player who plays the slice ball trajectory is the producing of low possibilities for intersection points.

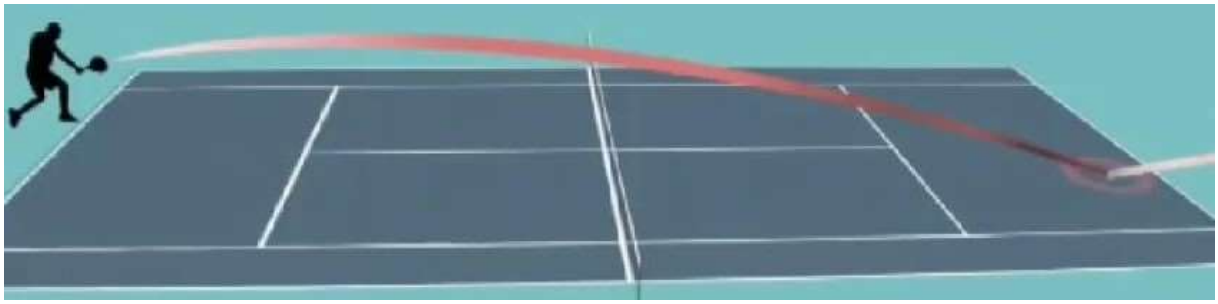


Image: straight *slice* ball trajectory; *the classical shape*: out of the backhand court hit cross-court.

[141] Chapter 1.3

A different straight ball trajectory has its origin in a flat (first) service as in smashes. The advantage of this ball trajectory is that it can be hit with maximum power/ball speed. The disadvantage is the lower success rate and the predictability of the outcome. The ball trajectory is a straight line and the ball speed takes care for the ball to exactly follow the imagined ball trajectory.

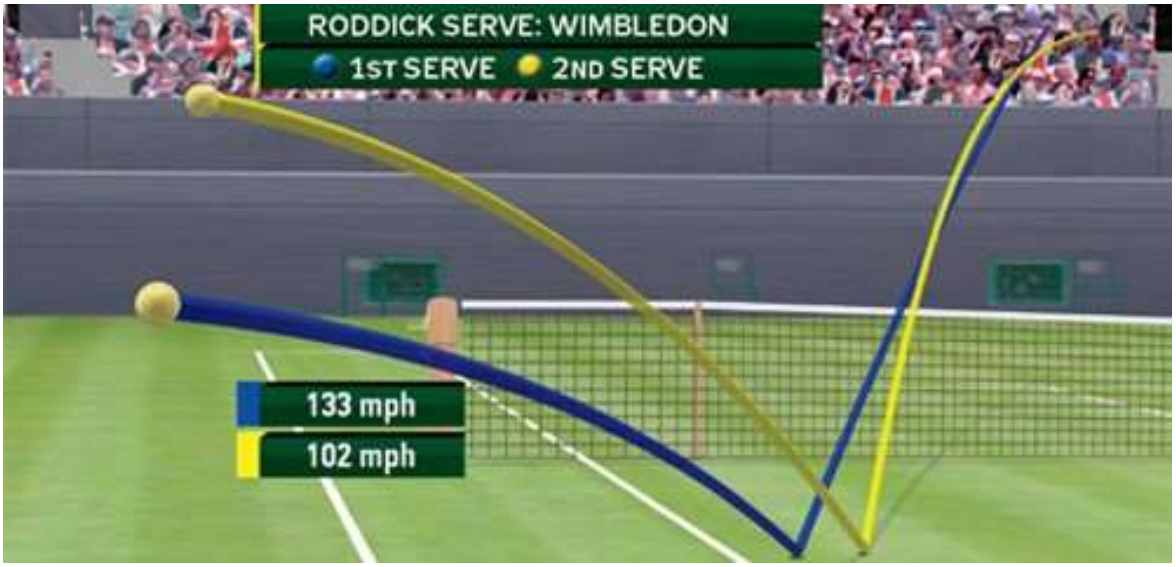


Image: Straight ball trajectory shapes (blue) and round ball trajectory shapes (yellow). Notice the straight ball trajectory is *rounded* after the bounce due to gravity.

Other straight ball trajectory shapes are produced out of volleys hit with good power.

c. Curved ball trajectory shapes

I. Slice services

Curved ball trajectory shapes form a minority in existing shots in tennis. In gameplay of elite players the biggest part of existing curved ball trajectory shapes one can find in the slice service. Slice services as compared to straight services have to give up a certain amount of ball speed. The ball trajectory shape however is much more unpredictable. In pro tennis the usage of the shot has been increased during the last decade. In olden days it was only used with unequal handed players. Than the slice was served to the backhand side. The supposedly weak side of the opponent.

from deuce-court to outside left

from ad-court to outside right

Images: Slice services (red ball trajectory)

Nowadays it is not meant to play to a supposedly weak side. Now it is played to manoeuvre the opponent outside the court and to let him return with power out of the 1st tempo. After the bounce the slice service stays low and moves away from the opponent. The opponent must intercept it in an early stage. If he doesn't do that the ball trajectory curves away more and more. An opponent is trapped. He has to defend his court and wants to create time somewhere. But he is also forced to intercept the ball trajectory in an early stage. The faster he returns the ball the more time he gives the server to score the return in the open court.

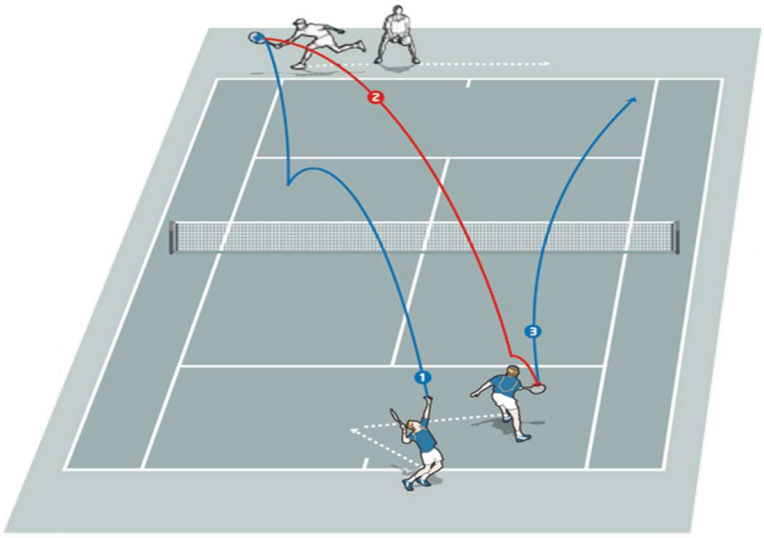


Image: A classic pattern - slice-service to the outside which forces a quick return with the scoring follow up.

II. Drop shots and *deflected* volleys

Drop shots and *deflected* volleys can produce very curved ball trajectories. Deflected volleys are produced by letting the racket head graze the incoming ball.
This kind of ball trajectories are mostly produced in the end phase of a ball trajectory chain. Then the rally will quickly be won by one of the players. A characteristic of these ball trajectories is the low ball speed at the end. So the ball stays low. The opponent has to come towards this ball and generate ball speed himself.

III. The *banana*-shot[142]

A ball trajectory which only a few pro players use in match play is the so-called *banana*-shot. A ball trajectory curved like the shape of a banana. It is one of the signature-shots of Rafael Nadal. He doesn't use it a lot. The game situation only occurs a few times in each match. And only if he is under real pressure and has only one chance to escape. I have hardly seen him fail the shot.
The ball trajectory has a characteristic low starting point.

[142] https://www.youtube.com/results?search_query=bananashot+nadal

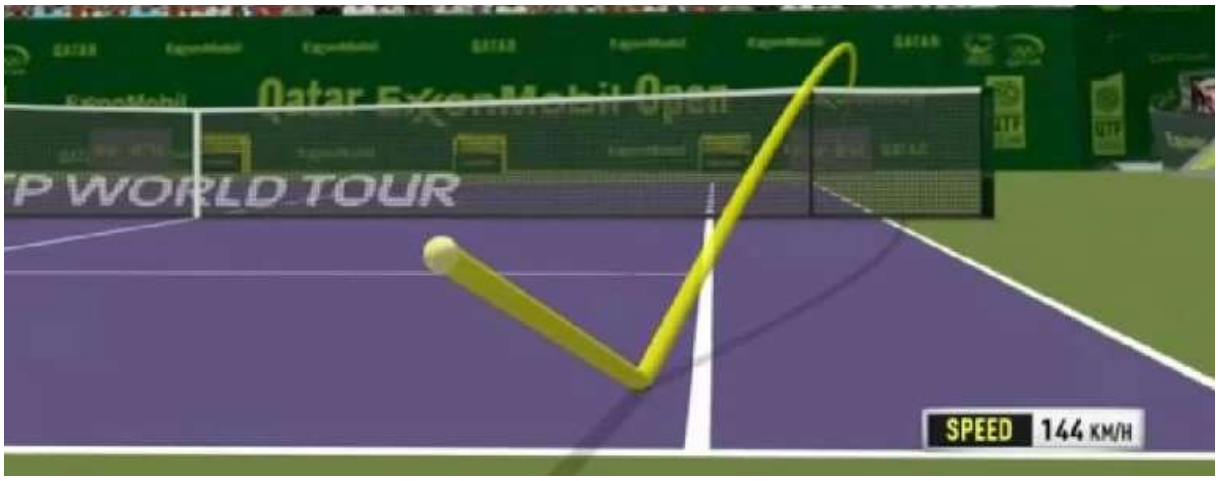


Image: Nadal's *banana*-shot ball trajectory.

5. Dualism in ball trajectories

The game of tennis is a perfect game in the sense that you cannot cover the whole court for 100%. But a player is able to cover the whole court reasonably well. Ball trajectories will not lead to direct scoring in the beginning of a chain. An opponent will then be in a position that he still covers the whole court reasonably. So ball trajectories have to move an opponent out of that position during a rally.

However there is a dualism in ball trajectories. I will first explain this in badminton. In comparison to tennis badminton contains a limitation of possible ball trajectories and ball trajectory shapes. The *ball* trajectories are mainly limited to a dropshot, a smash and a clear.

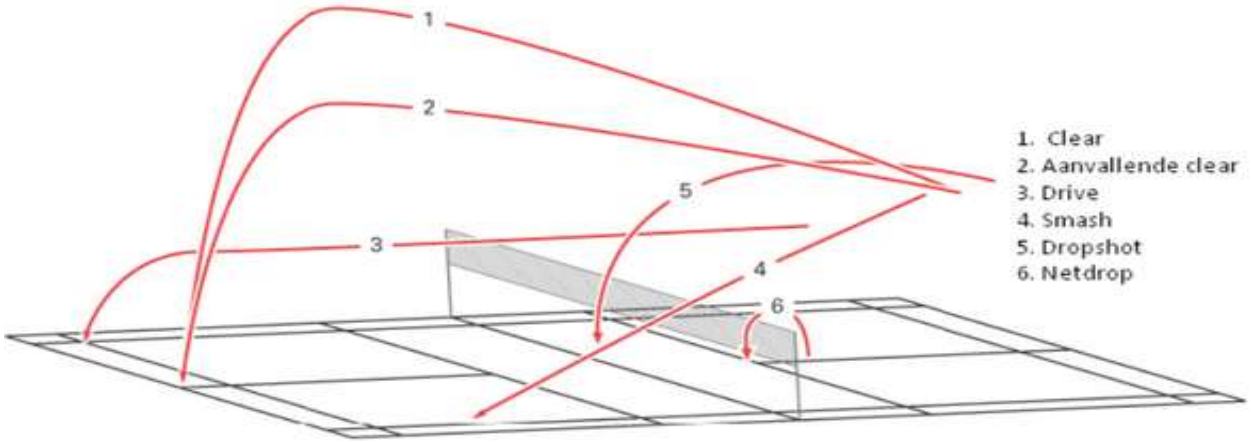


Image: *Shuttle* trajectories in badminton

Like in tennis the court can be defended in the same way. You can't cover it a 100% but you can cover it reasonably well. The dropshot is a strong shot because of the low intersection points it delivers but has the disadvantage that the ball trajectory takes a lot of time to deliver that low intersection point. The smash is strong also because of the low intersection points it produces but it has a low success rate

and the ball trajectory is coming towards the opponent. He doesn't have to do a lot to reach it. The chance of giving spatial problems to the opponent is low. The shuttle speed decreases rapidly. A pro player will not have problems with the vast majority of smashes. The clear is the high *ball* without any risk to keep the opponent in the back of the court. Mainly used to neutralise a rally.

All ball trajectories have advantages but at the same time have limitations. This is the dualism in ball trajectories. By the way this example teaches us that there is no room for ball trajectories consisting of half of this and half of that. Those ball trajectories are doomed to fail. A ball trajectory must consist the complete advantages of one particular ball trajectory and at the same time experience all the limitations of the chosen option. So a valid ball trajectory must carry this dualism.

In tennis the ball trajectories follow the same principles like in badminton. Some ball trajectories find their strength in their low ball speed. However these ball trajectories stay in the air for a long time after the bounce. A lot of ball trajectories find their strength in their ball speed. The dualism is situated in the fact that these ball trajectories will most of the time come towards the opponent. Although the action time is limited he has a chance to do something and he doesn't have to add a lot of energy to the ball to bring it back.
So the dualism in tennis follows the dualism in badminton. Players need to study this dualism thoroughly.

6. Models of ball trajectories

One can sufficiently develop models which explain the game of tennis in ball trajectories from beginner to the professional level. The shapes of the ball trajectories don't differ a lot in all levels. At the highest level a little more shapes are mastered. The big difference lies in the level depending factors[143] (LDF) and the ball trajectory defining factors (BTDF). Power/ball speed are huge factors in there. Lower round ball trajectories can only be produced once a certain ball speed is mastered.

Image: Round ball trajectories with maximum ball speed in the beginning of a rally.

[143] Chapter 1.3

In the basic rally elite players try to gain a little advantage with relative safe ball trajectories with a high success rate. They do that because they want to hit with maximum power. When they gain a slight advantage this will be broadened to control the tempo. Than you really dictate the rally. Elite players try to give this advantage a follow up in a dosed way. Dosed means that they just play a little better than the opponent and that the player enlarges the tempo to actual win the point. In this phase maximum power is abandoned because the used ball trajectories have a much lower success rate. The term in this phase is *good power*.
I usually explain this as a *natural power* that goes with the ball trajectory. It is definitely not slow hitting what some of my students sometimes ask me. I especially explain this here because there is still a huge misconception in tennis of fast, faster, fastest. Most power must be part of the beginning of a rally.

When the tempo is gained in the end phase of a rally and you want to create ball trajectories which will not come to your opponent the usage of less power has four major advantages.

1. You can create greater angles.
2. The tendency of the ball going out will diminish and so the success rate will increase.
3. The opponent will get *less power in his racket*. Opponents can easily exploit a lot of power due to the dualism in ball trajectories. A strong defending opponent will have much more problems if he also has to develop ball speed for an outgoing ball trajectory.
4. The ball trajectory will contain less energy so the shape after the bounce will stay lower to the ground. This will give lower contact points.

I followed Thiemo de Bakker (± top 100 ATP) thoroughly during the end season of 2015. Because of his ranking he was forced to play challenger tournaments. In that field of opponents he is the dominating player. That is logical because Thiemo should be ranked much higher.
In challenger matches he hardly won or just lost with only a minor difference in score he tried to finish the gain of tempo, which he received more than 80% of the time, as soon as possible. Weaker 2nd services he tried to finish in one shot. The success rate was far below average at around 20-25%.

In later matches that year it was noticeable that he executed the return of service in a much more dosed way. The answer to a weaker second service was now translated in a cross-court ball trajectory with good power instead of maximum power. With this tactics he put pressure on all his opponents. They either were deprived from space or time to handle the incoming ball trajectory with a success rate higher than 95%. With those tactics he won the matches rather easily against the same opponents.

It is rather easy to try to finish a rally with one shot. It is much harder to do that by playing just a little better than your opponent. For the latter you will have to train intensively to adapt your gameplay to all specific opponents you will meet.

You can very well observe this in the equal basic rally of Djokovic. First he will gain the tempo in 3-5 strokes and then he will cash in that advantage in 3-5 strokes by scoring or forcing the opponent to an error. It is very patient gameplay and completely adapted to his opponent. The very dosed gameplay ensures him the highest success rate.

7. Scoring patterns

If a player is able to produce a couple of outgoing ball trajectories with one exact goal than you can speak of a pattern. A player oversees and fully anticipates the incoming ball trajectories of the opponent. Scoring patterns will appear after a player gained the tempo and will be able to manipulate the opponent till the end of the rally.

Players need to develop insights in first universal scoring patterns and second player specific scoring patterns. Finally they need to learn how to apply these scoring patterns in an opponent specific way. To just play a little better than your opponent will give the highest success rates.

8. Reference ball trajectories

In tennis the producing of the exact same ball trajectory is impossible. A bobsleigher or a free diver will come more closely to the precise repetition of the trajectory to be made. There are far too many factors in tennis which result in each ball trajectory being much different than all the other ball trajectories. Even in the same game situation. In the more than hundred years of history in tennis there probably have never been constructed two ball trajectories exactly the same. Luckily there is no need to achieve this goal. In a game situation it is sufficient to reproduce the shape of the ball trajectory and the ball trajectory defining factors (BTDF). For example inflection points must be similar in ball trajectory shapes.

So one is not able to teach one similar ball trajectory. There for coaches need to work with reference ball trajectories. A reference ball trajectory is the ideal ball trajectory which is one of the solutions in one certain game situation. Reference ball trajectories have a shape which is immediately clear to everyone. In other words one could say that they are black/white ball trajectories.
A player needs them as an image in his cognitive basis. Reference ball trajectories help him in making visual perceptions while actually performing the Game Action. These abstractions of ball trajectories guide the actual ball trajectories. Or in other words the black/white abstractions guide all the grey tones of actual ball trajectories in match play.

In my lessons I always start with a 45° round ball trajectory. Players have to produce them out of the 2nd tempo. In the same lesson I often introduce a 8º round ball trajectory. This is an attacking ball trajectory out of the 1st tempo. On paper 8º sounds a little bit vague. Players however recognize it immediately and have no problem with it whatsoever.

Sometimes players are skeptical about training a 45° round ball trajectory. Then I show them the lobs of Andy Murray[144]. This year (2015) he added a new dimension to his "counter punching" in producing this kind of ball trajectory in all sorts of game situations

In the next lessons in which I review everything thoroughly I soon add a 30° round ball trajectory. And soon after that a 15° round ball trajectory. For this last ball trajectory players must be able to produce a certain ball speed. Because otherwise the ball will never reach the opposite side of the court in a useful way.

In the basic baseline rally elite players mainly hit 15° to 30° round ball trajectories out of the 2nd tempo. One of the goals is to keep the opponent behind the baseline. The 15-30-45 degree ball trajectories all share the same characteristics. They only differ in elevation angle.

[144] https://www.youtube.com/watch?v=rF7sRN1vukI Andy Murray - Top 10 Breath taking lobs of 2015

The reference ball trajectories which I use in lessons are actually needed in gameplay at each level. So I don't need to use reference ball trajectories which are useless in itself. It is sometimes inevitable to use references which are in itself useless but necessary in a progression of motoric learning. In this case no time is wasted on useless references.
Besides that it is always good to have multiple reference ball trajectories in one game situation. In that way the reference ball trajectories form a reference for each other. In that way differential learning can be achieved by just training reference ball trajectories. The speed of motoric learning will be increased by doing so. Gameplay with reference ball trajectories can be a nice phase in between producing only reference ball trajectories and complete gameplay with all the grey tones of ball trajectories. Of course the latter is the ultimate goal.

Talking about this in between phase. In drills a teacher can easily produce a steady fixed shape of an incoming ball trajectory. But of course he cannot produce the exact same ball trajectory every time. This will also take care for a good transition from the black/white ball trajectories to all the grey tones of match play. So with MindTennis you can visualize the perfect ball trajectories. With drills and playing with reference ball trajectories you gradually can develop a player to full match play.

The above mentioned 8-45 degrees ball trajectories are part of the Main Game Situation: Baseline. In the MGS: PaN (playing against the net player) there are four reference ball trajectories to be trained initially. After a Fh-cross rally and a long line approach the next possibilities can solve the tennis problem at hand. 1. A short cross-court passing shot. 2. A cross-court lob. 3 A long line passing shot. 4 A ball trajectory towards the hitting shoulder of the net player.

In this game situation all reference ball trajectories must be well known. At first with no concern to the position of the net player. However soon both players have to learn if the opponent is anticipating a certain ball trajectory by covering certain options. Out of the game principle that you can't cover everything completely in tennis but you can cover the whole court in a sufficient way anticipation to a certain option will show more opportunities in the other options. Bigger *holes* will appear.

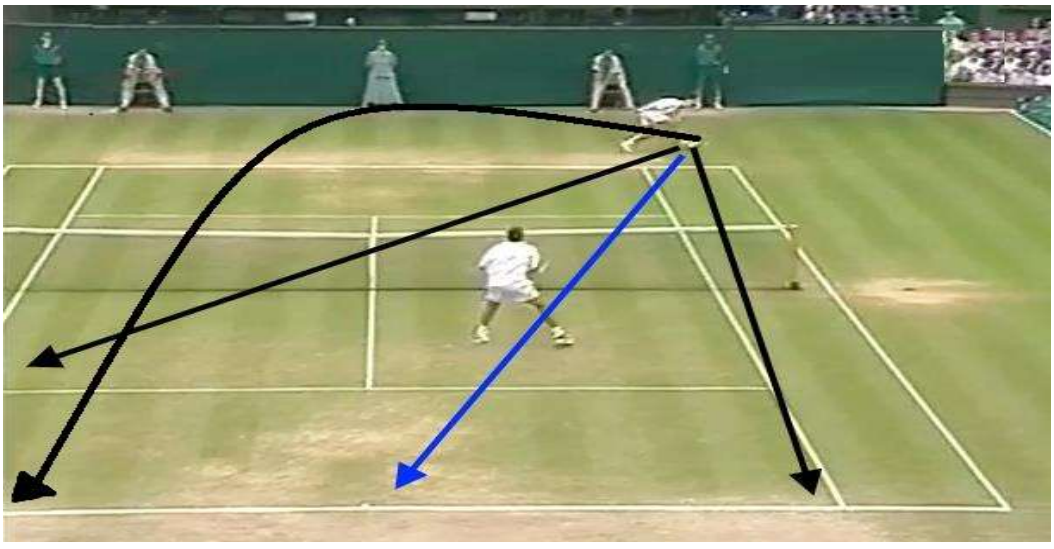


Image:Single; MGS: PaN; four reference ball trajectories as a fundament for the actual solution to this exact situation. The black ball trajectories mainly need shape. In the blue ball trajectory the main factor (BTDF) is ball speed[145].

[145] Chapter 1.3

While practicing this game situation players need to change roles frequently. In this game situation the roles of the players differ immensely. By changing positions frequently both positions work as a reference for each other. Implicit motoric learning will be optimised out of this differential learning approach.

9. Ball trajectories do not lie

In short I discuss here a part out of my book about Motoric Movement Actions[146]. Here I will mainly describe the practical consequences towards tennis.

Ball trajectories are the action trajectories in tennis. However if we examine ball trajectories on a micro level we have to make subdivisions. The ball trajectory fulfils the task action and that is why it is the action trajectory. However in the technique one can also distinguish *action* trajectories. In rowing f.e. the progressing boat fulfils the task. The line of that progressing boat is the action trajectory. Within the technique the pull (with the arms) or the push (with the legs) against the board are examples of two other different *action* trajectories within rowing. In my book I explain that those *action* trajectories have no relationship whatsoever to the action trajectory of the boat. The action trajectory of the boat belongs to the Movement Action. For every Movement Action there is only one action trajectory. The other *action* trajectories belong to the execution of the Movement Action of that one action trajectory. They belong to the Motoric Movements of the Motoric Movement Action. I call those *action* trajectories *movement* trajectories. There are always multiple movement trajectories in one Motoric Movement Action. In one technique they have set relationships with each other. The direction of the movement trajectories have no relationship to the action trajectory.

In the example of rowing the action trajectory is simple. The task is simple. You can row at a top level without knowing the action trajectory. However flow or rowing in the zone will never occur. To achieve that the motoric movement trajectories must be connected to the action trajectory. That is the only trajectory which will fulfil the task.
From the *floating* of a boat (the action trajectory) a rowing coach can exactly determine the problems in the boat. This *outside* floating never lies. The motoric movement trajectories in the boat soon become part of subjective discussions/conflicts. The action trajectory is the objective element.

The action trajectory in tennis is the ball trajectory. In comparison to rowing the action trajectory in tennis is much more complex. You can't play tennis at the highest level if you are not aware of these action trajectories. Even too much emphasis towards the motoric movement trajectories in relation to the action trajectory is doomed to fail.

There is a lot of scientific research that studies the relationship between external focus and the effect to motoric learning. There is a lot of discussion about the outcome of that research. Researchers don't find unanimous results. However one thing is clearly shown in all research. The further the focus becomes from the body the more effective motoric learning gets. Like this book shows there is no research that studied the relationship between external focus and the action trajectory. In tennis research one focussed on the hand, the arm, the racket and more but never on the ball trajectory. Till now it has been overlooked. My research shows that it is the missing link. Ball trajectories form the ultimate possibility to put an external focus on. A further focus is not possible.

[146] Caught In A Line ~ *The Motoric Movement Action*; N.J. Mol – january 2017

Besides that a tennis coach, like in rowing, can exactly see in a ball trajectory what is missing. When you train reference ball trajectories you have to fulfil a certain ideal shape. The ball trajectory never lies. There is no vagueness. Discussion/conflict will occur if one focusses on other external possibilities. If one focusses on the usage of the racket the observation at once becomes more subjective. A coach can have an opinion about something what the player experiences in a different way. You can experience this on a daily basis in all trainings sessions.
While training ball trajectories you could even determine what is a 45° round ball trajectory and what is a 44°or 46° round ball trajectory if you want to joke around a little. Player and coach will witness the same thing.

If you transfer the external focus from a body part or racket to the ball trajectory you also achieve that you leave the technique out of the game equation. The game demands a player to shape a ball trajectory in a certain way and on a consistent basis. How the player fulfils that demand is completely up to the player. This observation is fully in line with the placement of technique outside the Game Action. It is the only way to *flow* or *playing in the zone*. It is the only way in which *self-2* can be developed to its maximum.

10. Ball trajectories come towards you or they don't

Sometimes when you write something you seriously doubt what you are writing. But I cannot explain it better than this. It is an important essence of the game of tennis. It decides if a player can perform the Motoric Movement Action out of the same position or if a player must perform a movement pattern with his legs first. In my book about the Motoric Movement Action I explain this in detail.
This is related to the dualism in ball trajectories. Imagine yourself on the baseline. It doesn't matter how much ball speed the ball has if it comes to you, you always will have a chance to hit it. In comparison to this incoming fast ball you don't have one chance in hitting that super soft ball which is played just out of your reach. Didn't you ever play doubles against (senior) opponents who didn't play with a lot of power but everything just out of your reach. Maybe that is even more frustrating? Then you rather prefer a fast ball which nearly misses you.
In ball trajectory defining factors (BTDF) direction is hardly ever the dominant factor. With that soft ball direction is very important as well as adjusted ball speed. Most of the time it is essential to be able to put a lot of speed into the ball. In this case it is very important that a player can put a low speed into the ball. Ball trajectories with a lot of speed will most of the time come towards you.

In my lessons I use two practical volley exercises besides technical volley exercises. One practical exercise is an exercise where the ball will come towards the net player with a maximum of speed. Like in catching a player needs to learn to push his feet into the ground (and not to jump (!); which everyone does in the beginning) and to let the ball come towards the racket. Like in the Return On 1st Service (ROS[1]) at the highest level a player needs to achieve a higher success rate by putting the catching task far in front of the throwing task. The success rate will rise exponentially if a player will be able to stretch the time of the incoming ball trajectory phase.

In the second practical exercise I use a much slower incoming ball trajectory. Because of the dualism in ball trajectories this ball stays in the air for a much longer time. It *hangs* in the air. This ball trajectory will not come towards the player. A player needs to learn to take a sprint towards the ball. Although the player also needs to learn to let that ball come to a visualized intersection point.
In combination drills the two exercises are mixed. They are the two ends of the spectrum of existing volleys in nowadays match play at the highest level.

11. Almost perfect ball trajectories

If pro players are not rushed they are able to execute a wanted outgoing ball trajectory with a high success rate. When they need to hit a winner in a final phase of a rally a big percentage will succeed at once. You can call this outgoing ball trajectory perfect. A percentage of these outgoing ball trajectories will not succeed right away. They are almost perfect. An almost perfect lob can just be touched with the edge of the frame. A very low almost perfect passing shot can just be touched with a complete stretch of the arm. Remember that the game of tennis is so good because of the principle that you can't cover everything completely but you can cover everything sufficiently.

So even if ball trajectories are executed well there is a chance that the opponent can get a racket on the ball. But without a real Game Intention. Those ball trajectories I call the almost perfect ball trajectories. Those are the ball trajectories which are executed with a certain Game Intention and have received a lot of that Game Intention but just didn't end in the optimal result. It means that the opponent will experience a huge percentage of the negative intentions which were planned towards him. This is very common in tennis. There will be good chances to finish the not completely perfect ball trajectories if the player who executed it anticipates well to the outcome.

Two pro players who on a daily basis live with these not completely perfect ball trajectories are Andy Murray and Ivo Karlovic. Andy as a counter puncher manages to keep pressure on an attacking opponent with the maximum of defending ball trajectories. He knows that a lot of the time they will not be perfect but they succeed 80-90%. He knows before hitting what consequences could face him later on. Just after the hitting he is already on his way towards an optimal position to face these consequences with a winner.

Image: If a player encounters a game situation in which his opponent has to stretch his arm to just touch the ball than the chances for the player can be very successful. The opponent must structurally built this into his reference ball trajectory patterns. This almost perfect ball trajectory will give a lot of opportunities to finish the rally with the first outgoing ball trajectory.

Ivo Karlovic hits a lot of aces. But he also hits a lot of not completely perfect services. A lot of almost aces are returned by fortune and don't carry any Game Intention from the side of the opponent. Karlovic has a large library of the most bizarre returns which just make the journey back to his side of the court. He structurally has to train all those lucky returns and finish them with the second shot.

Chapter 11 – The GBA ~ consequences for daily practise ~ *MindTennis*

1. Introduction

MindTennis is the playing of the game of tennis inside your head. It is about the visualization of ball trajectories you can witness in the DemoClip. With MindTennis you can perfectly train all the black/white reference ball trajectories. Although you can train grey tones as well. Besides that you can train the anticipation to all the movements opponents can make. After the Initial Phase of the incoming ball trajectory an opponent has to show his further intentions. If an opponent suddenly approaches the net after a hit he is bound to move to universal positions at the net. A player must be able to switch in no time from the one cognitive program in a certain game situation to the other cognitive program in the other game situation.

The appointing of the Game Action makes it possible to fully play *the game* of tennis within your mind. Remember that the technique takes no part whatsoever in the Game Action. The Tactical Tennis Action is completely trainable off-court. It is a complete complex (sub)system. The training of MindTennis off-court doesn't harm anything. In a worst case scenario that players, due to injuries, are not able to train for months MindTennis is at least an alternative.

The name MindTennis is a reference to all those woolly (mental) methods which combine the *mind* with something. MindTennis on the other hand is not a woolly method at all. It is a very clear and concrete answer to all the vaguely formulated forms of anticipation. Just like the game of tennis a player was held responsible concerning anticipation. Coaches told players to anticipate but hardly translated that in practical exercises. The Game Action and MindTennis completely absolve players from all responsibility. The coach will become the main responsible person. The coach must establish that a player is going to anticipate.

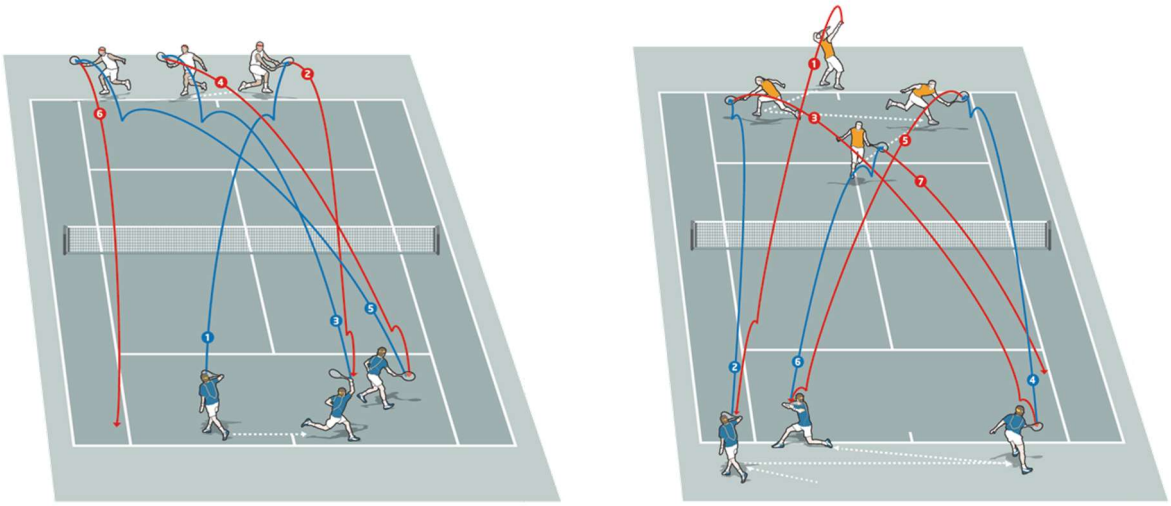
"MindTennis is the complete playing of the game without a racket."

MindTennis is the one to one follow up to what you constantly train on court because of the Game Action. The same visual perceptions are involved. The only difference with MindTennis is that you don't hit a ball. It takes place inside your head and that means that you can play it alone. Against yourself. You hit a ball, you *jump* over the net, receive the ball in an intersection point and hit it back. You can play it with multiple persons against each other but also from one point of view. You can play it in player or spectator mode.

If you play MindTennis with multiple persons than communication is needed. A lot of the time there will be communication with words but there can also be communication with ball trajectory drawings

om paper or other devices. The *language* has to contain all the elements which are essential to the Game Action. Tempo, game situation, pressure, shape of the ball trajectory, line of movement, Game Intention, ball trajectory defining factors (BTDF) etc. have to be appointed over and over again. A beginning MindTennis player is only allowed to play MindTennis with an experienced coach. A coach must be able to give the correct information but also needs to correct the player about his own possibilities. With MindTennis you play your own tennis what you can display on the court. If a player *trains game situations* in MindTennis with a forcing slice service out of the court a coach has to correct him by telling him that he is a few years from having a forcing service like that.

When I invented MindTennis I thought: "Okay. Nice. Something funny to use in combination with the Game Action.". At first I didn't want to dedicate a whole chapter to it. Was it that important? I completely turned around. Now I think that MindTennis should fulfil a pivotal central role in the career of a tennis player.



Images: MindTennis; *the visualization of real ball trajectories*

The Game Action is appointed out of a complex system. So there are no linear training methods possible. Training methods fulfilling the Game Action will also have to comply to the characteristics of a complex system. MindTennis is very well able to serve as the central element which combines all the processes within the Game Action.

In this chapter I will appoint all aspects of MindTennis so that the pivotal role will become clear and that it takes care of the fact that MindTennis will get an important place in the career of a player.

2. Cognitive image library

The Game Action has shown the very complex nature of the perception processes. Those perception processes are just for a small part the actual vision.

"There is much more to perfect vision than having normal eyesight. While the term "sight" emphasizes the clarity of image on the retina, vision encompasses a broader meaning as the mental process

of deriving meaning from what is seen and is the output of visual pathway integrity, visual efficiency and visual information processing.[147] *"*

Those perception processes follow the perception processes like in all Motoric Movement Actions. They will get meaning and a task only when there is cognitive knowledge about possible action trajectories. For every Motoric Movement Action there must be a cognitive basis which answers the questions of the *how* and *why* in an abstract way. Even for the simplest of tasks. MindTennis is structurally working on the enhancement and the improvement of quality of that cognitive basis.

"Vooral in de laatste twee decennia heeft het sportwetenschappelijk onderzoek overtuigend aangetoond dat prestaties in de sport niet alleen worden bepaald door de techniek van de bewegingsuitvoering maar ook door de kwaliteit van de waarneming. Door het vroegtijdig oppikken van o.a. visuele informatie kan beter worden geanticipeerd op komende gebeurtenissen en kan eerder een beslissing worden genomen over de te nemen actie.[148] *"*

There is a sliding scale from simple to complex Motoric Movement Actions. Tennis can be coupled to the one end of most complex Motoric Movement Actions. Because of the many game situations there is a huge number of possible action trajectories which can fulfil the task. There are many game situations and with each game situation there are multiple possibilities. A rough estimate tells that a player must have around a few hundred action trajectories at his disposal in order *to post* a ball. And then we just talk about the universal development of a player. At a sudden moment there will rise a need for player specific action trajectories. Out of a strong/weak analysis a player will face certain game situation much more and wants to explore it in the tiniest detail. Ivo Karlovic has cognitively classified a huge number of service returns in such a way that he also subdivided the returns of one category.
All these hundreds of action trajectories must become a part of the cognitive basis of a player. This image library must be built from scratch within every player. The construction of this image library must go from universal to player specific to opponent specific.
The cognitive basis shapes reference ball trajectories for the actual game situation. It works as a blueprint for the Actual Tennis Action and the Tactical Tennis Action if tennis is played in full.

"The relationship between vision and skilled movements is not a spontaneous muscular response but represents a sequence of complicated processes within the central nervous system. An athlete absorbs information from the surrounding sporting environment and processes this information. The final output produces a movement response. This model of humans as information processing systems is commonly used to explain the role of vision in producing and controlling skilled movement. The human performance model was originally presented by Christenson, Winkelstein, (1988). The model assumes that perceptual-motor performance occurs when sensory input information is converted into a purposeful output action. In between the input and output actions information passes through 3 hypothetical central processing mechanisms .

Perceptual mechanism
This mechanism receives information from receptors such as the retina for visual information and the inner ear for balance information. The perceptual mechanism re-organizes and interprets the information. The selection of information can be influenced by the athlete's previous experiences.

Decision mechanism
Information from the perceptual mechanism is passed through to the decision mechanism, which decides the appropriate action. This mechanism is concerned with response selection and strategy formation. This can also be influenced by the athlete's previous experience.

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[147] Impact of Visual Skills Training on Sports Performance: Current and Future Perspectives; S. Khanal; http://medcraveonline.com/AOVS/AOVS-02-00032.pdf
[148] G. Savelsbergh; Tussen de linies spelen; http://www.fsw.vu.nl/en/Images/Oratie_Prof._Savelsbergh_tcm250-108263.pdf

Effector mechanism
If the decision mechanism selects a motor response, the relevant information is passed onto the effector mechanism, which controls and organizes the sequence."[149]

In the current education programs cognitive knowledge is only widened in on court training sessions. MindTennis will accelerate this process immensely because there is much more time off-court than on-court. And at the court you also have to learn other essentials. So the benefits are twofold. On court you don't have to spend time on this anymore and off-court you can spend much more time to it. MindTennis will take care that all relevant information becomes crystal clear and that all options in the relevant game situations find a place in the cognitive basis of a player.

"The technical and tactical proficiency and physical prowess of an athlete is often used as a means of distinguishing the elite from their lesser skilled counterparts in fast-paced interceptive and team sports. Not surprisingly, then, a large proportion of training time is spent refining these qualities. However, there is also a less-obvious quality that is of equal importance to performance that can distinguish between differing skill levels. Decision making skill1 is the ability of a player to quickly and accurately select the correct option from a variety of alternatives that may appear before the ball is hit or kicked or an opponent moves. Colloquially, decision making is often referred to as reading the play.

-Expert decision makers are not born, but made through a combination of their developmental experiences as children and then through quality coaching that provides on- and off-court decision-making training opportunities.

- The recipe of becoming an expert decision maker, in our opinion, is to systematically combine on-court training focusing on the execution of what and how decisions with off-court training. That is, all steps of the decision-making process, particularly the components of generate, consider and select, should be part of both types of training though not necessarily presented in an explicit manner.[150]"

3. Introduction and development of MindTennis

In learning processes we know the rule of Tell, Show, Do and Apply[151]. If there are breaks in between the four phases it can do a lot of harm to the effectiveness of the learning. MindTennis is mainly centred around the first two phases. In the first development stage of a player there must be a definite relation between what is *trained* in MindTennis and exercises on court. They must reinforce each other out of a holistic approach. This is a plea for relative more but smaller training sessions structurally combined with MindTennis sessions..

If there is a solid basis in MindTennis than a quick follow up is less necessary. MindTennis is a complete complex system in itself. Training it independently doesn't harm anything. Of course there must

[149] The Impact of Visual Training on Eye Search and Basic Skills among Female Handball Players; H. Labibi; http://www.analefefs.ro/anale-fefs/2014/i1/pe-autori/10.pdf
[150] Farrow & Raab; Receipt to become an expert in decision making; http://www.researchgate.net/profile/Damian_Farrow/publication/43525837_A_recipe_for_expert_decision_making/links/0c96051e3cf2f7c161000000.pdf
[151] http://elearningindustry.com/tell-show-do-apply-the-anatomy-of-good-instruction

be structural on-court training sessions. That means that all relevant ball trajectories of a certain learning period must be reviewed over and over again. In that way MindTennis is continuously confirmed on court.

Before you will be able to play MindTennis a player first has to gain practical knowledge about reference ball trajectories. One can establish that most effectively in an on court training starting with one reference ball trajectory and to only focus on the Actual Tennis Action. The Actual Tennis Action is only concerned about making chains of ball trajectories. Then without pressure of winning the point players are able to learn all the essential actions of the Game Action in a relaxed way.

First I will give an example of an introduction lesson in ball trajectories and then an introduction lesson in MindTennis. It is a linked *on-* and *off*-court training. The actual trained ball trajectories are also the subject of the MindTennis training.

Example lesson 1

On-court

Group elite players; age 10-12. The group did previously warm up.

Goals:

a. Execution, visualizing of and anticipation to 45° round ball trajectories.
b. Introduction of definitions and the practical use of: angle of elevation, Initial Phase, to hit a ball in its ball trajectory, 1st tempo/2nd tempo etc..

Exercise 1 (main goal is the production of a 45° round ball trajectory)

a. Instruction. Explanation of 45° round ball trajectories (tell and show). Practice: Kids play a cross-court rally which should be easy for elite youngsters.
b. Instruction - Rationally deepen the knowledge how this ball trajectory is actually produced. Where exactly is it made? Appointing 1st and 2nd tempo. Ask more attention to the reception phase and the angle of elevation. Ask a more active search for information and to hit the ball into the outgoing ball trajectory which is already there in a latent form.

Practice: The quality of the actual shaping of the ball trajectories must increase. I want players to actually correct themselves by appointing the degrees of the wrong ball trajectories and to confirm almost perfect 45° round ball trajectories.

c. Instruction: Ask attention to the shape of the ball trajectory. Visualization with eyes closed. Practice: Than train this visualization while you do the former exercise.

Short break.

Exercise 2 (main goal is the visualization of incoming 45° round ball trajectories even before the opponent has hit the ball)

a. Instruction. Explanation that an opponent must continue the chain from where you *construct* the end of a ball trajectory and if you create an Initial Phase of a 45° round ball trajectory the shape at the end will be similar. You will be able to visualize the cross-court answer of your opponent even before you hit the ball yourself. The rally is restricted to 45° round ball trajectories.

Besides the actual cross-court answer two other latent answers must be visualized. I.c. the same ball trajectory long line and in the middle of the court. The actual rally must continue to be cross-court.

b. Practice a
c. Instruction and practice a. One player can actually hit one of the two other options as well. The other player will just mirror the choice.
d. Instruction and practice a. Now both players can actually hit one of the two other options. With the ongoing task to visualize all three latent options before you hit the ball.
e. Instruction. Ask attention for the quality of the visualization. Try to visualize the almost perfect 45° round ball trajectories you just constructed with your eyes closed. Repeat (b, c?) d.

Practice. Repeat (b, c?) d.

Remark:

The whole lesson would find a big support if a tracking system like Zenniz[152] could be used. With systems like Zenniz you can watch a played rally just a fraction in time later. Especially for children it is the ultimate challenge *to create* the perfect rally.

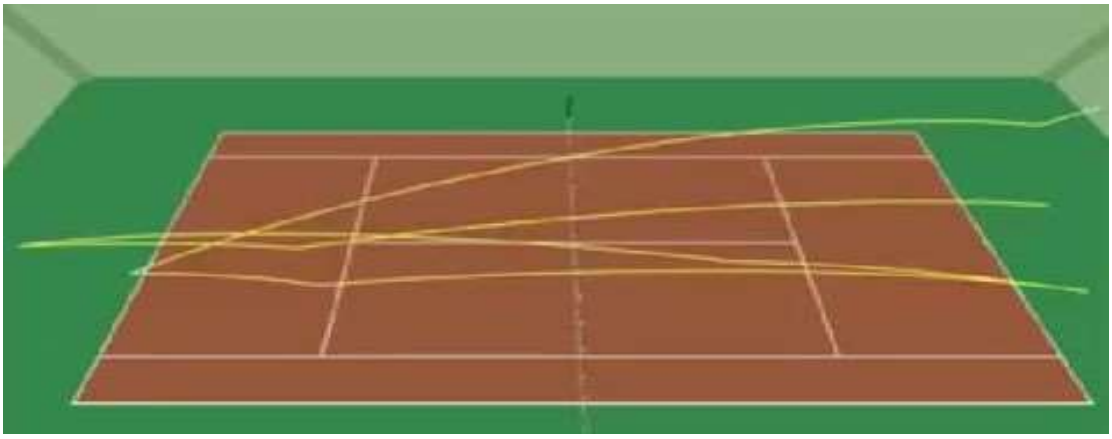

Image: Zenniz; the possibility to actually see your just played rally in ball trajectories

End of on-court training.

Off-court

Introduction lesson MindTennis. The same group; the same day.

1. Introduction with
    1. Short video clip of Andy Murray (The master of 45° round ball trajectories)
    2. Zenniz clip of a perfect rally of two players which was just realized in the on-court training.

2. Exercise 1 – solo (main goal is the constructing of a 45° round ball trajectory with MindTennis)
    a. We go back to the on court training. Close your eyes and try to make a 45° round ball trajectory. You have a ball in your hands. You throw it up and with your racket you make an 45° angle of elevation towards the ball. Hit the ball into the previsualized shape. Fine. Repeat it. Than fly to the other side and see how the ball bounces and rises with a 45° angle

[152] http://www.zenniz.com/ https://www.youtube.com/watch?v=NDn_ucrw-I4

to the highest point. Let it come down and see the 45° descending line. You use that line (2nd tempo) to hit the ball back. Repeat a few times.
b. Repeat a, first visualize the whole ball trajectory.
c. Play a cross-court rally with yourself. Keep on visualizing the ball trajectory before you hit the ball into it.
d. Play a cross-court rally with your favourite player.
e. Repeat d, but visualize the ball trajectories as a spectator.
f. Repeat d in player mode.

Short break.

3. Exercise 2 – in couples (main goal is the visualization with MindTennis of incoming 45° round ball trajectories even before the player hit the ball (OBT^{-1}))
   a. Play a MindTennis cross-court rally with 45° round ball trajectory shapes. Appoint together the essential shapes and actions.
   b. Like 3a. Appoint only your own ball trajectory and actions.
   c. Like 3b. Repeat on court exercise 2a.
   d. Like 3b. Repeat on court exercise 2b.
   e. Like 3b. Repeat on court exercise 2c.
   f. Like 3b. Repeat on court exercise 2d.

4. Homework
- Repeat exercise 2 of the MindTennis lesson.

End of instruction.

This lesson will be reviewed in full the next time and expanded with a 30° round ball trajectory. Now you have to visualize six possible answers instead of three before every ball you hit. That seems a lot but players get familiar with it very soon.

The introduction will optimally succeed by only training the Actual Tennis Action. However soon it must be coupled to real game situations. But first there must be a kind of consistency in reference ball trajectories. The body needs a certain time to get familiar with the new visual language.

The next example is an example of a MindTennis lesson with a real game situation involved.

Example lesson 2

Single, Baseline, cross rally (with 30° round ball trajectories)

Mission: If a player is forced to the side of the court and has to make a contact point outside the court he has to make a shot long line (*bad guy*). The essence of a contact point outside the court is that the long line incoming ball trajectory is always coming back towards the player (*good guy*) and that the court of the opponent (*bad guy*) isn't covered correctly. He needs time to cover it. The good guy has to take advantage of this situation.
With MindTennis the good guy must incorporate the next possibilities in reference ball trajectories in this game situation:

1. If the opponent chooses to create an incoming 30° round ball trajectory with good pace and direction then the good guy has to make a (diagonal) line of movement backwards and create a 30-45° round ball trajectory, deep cross-court, out of the 2nd tempo with the outcome of an

equal rally. The good guy will experience a little pressure. He has to make a little higher shaped ball trajectory with little less ball speed. If he creates a low ball trajectory with maximum ball speed he will worsen the pressure. Then the ball will arrive at his opponent too soon while the good guy also needs to cover his court in a sufficient way.

2. If the opponent chooses to create an immediate scoring passing shot (*shot to nothing*; with a very low success rate) than the player has to make one big step (*lunge step*) to the corner and block the incoming ball trajectory and play it short or deep cross court. Because of the ball speed the ball will be back so soon in the court of the opponent that he will not be able to get to the ball ever.
3. If the opponent chooses to create an incoming 15-30° round ball trajectory with the direction more to the middle of the court and/or has less ball speed than the player has to step into the ball, take the first tempo and produce a scoring 8-30° round ball trajectory cross court. The bad guy puts pressure on himself by choosing a low and fast ball trajectory. He will never be able to cover his court sufficiently.
4. If the opponent chooses to create a 45° round ball trajectory *without loss of tempo* deep into the backhand corner than the player makes a line of movement backwards and creates a 45° round ball trajectory cross court out of the 2nd tempo with the goal to continue with an equal rally.
5. If the opponent chooses to create a 45° round ball trajectory *with loss of tempo* deep into the backhand corner than player can step in take the 1st tempo and make a building (B) shot. The bad guy creates time for himself but now he has to choose a side of the court like the goal keeper in soccer trying to anticipate a penalty kick. The good guy must take advantage of the gain in tempo.
6. If the opponent chooses to create a 45° round ball trajectory *without loss of tempo* with a bounce around the service line (heavy topspin) and good direction than the player creates a 30-45° round ball trajectory out of the 2nd tempo cross court with the goal to maintain an equal rally.
7. If the opponent chooses to create a 45° round ball trajectory *with loss of tempo* with a bounce around the service line than player has to make a line of movement forwards and hit a scoring passing shot.
8. If the opponent chooses to create a 45-60° round ball trajectory (mishits) *with extreme loss of tempo* with a bounce around the service line than player
   a. has to take a sprint towards the ball and make a scoring punch volley cross court just behind the net.
   b. has to take a sprint towards the ball and make a scoring drive volley cross court deep.
   c. has to take a sprint towards the ball and let the ball bounce and wait for the opponent to decide which side he is going to defend. Player makes a scoring 8-30° round ball trajectory with low ball speed out of the 2nd tempo in the open court.
9. If the opponent chooses to create a straight ball trajectory (slice) with normal ball speed and good direction than player has to make a diagonal line of movement backwards and create a 30-45° round ball trajectory cross court out of the 2nd tempo with the goal to maintain an equal rally.
10. If the opponent chooses to create a straight ball trajectory (slice) with less ball speed and/or good direction than the player can step in. The bad guy will be able to recover well and the low contact point doesn't give possibilities. The good guy will be able to maintain pressure by taking the 1st tempo.
11. If the opponent chooses to create a dropshot than the player has to make a sprint forwards and make a cross court scoring shot just behind the net.

Remark 1:

The good guy knows just after the Initial Phase of the outgoing ball trajectory (OBT^{-1}) if the ball trajectory is going to have a contact point outside the court. Before the opponent hits he must visualize all the possibilities out of the probable intersection point zone this specific OBT^{-1} will give. If you are not used to it this seems a hard thing to do. However:

a. It is what the Game Action prescribes. If you want to play the game optimally you need reference ball trajectories.
b. It is an ending sequence. There are around 10-15 options and that is it. You don't have to learn each month two more new options. If you know them you know them for the rest of your professional career.
c. The principles repeat themselves over and over again. So with the first game situation everything is new and you have to get familiar with all the options. With the second game situation some options are already known. It is all unequivocal and uniform. After a few weeks you don't know any better.

Remark 2:
Players get homework assignments to play MindTennis at home or with their colleagues. On court this is structurally reinforced. In very closed drills (drills A1) the black/white options will be mastered. In a little more open drills (drills A2) some of the drills A1 will be combined. Than the whole game situation (but only the game situation) will be trained in an exercise (B).
With MindTennis the ball trajectories can be visualized perfectly. In a drill A1 some deviation will occur. A teacher can perfectly feed the same shape of a ball trajectory with identical ball trajectory defining factors (BTDF) but of course never the identical ball trajectory. So from MindTennis to real all open match play there is a gradual transition from black/white reference ball trajectories to all the grey tones the player will actually meet.

4. When is MindTennis introduced?

Players can start with MindTennis when they can rationally make an image of a ball trajectory. It demands a certain abstraction ability. Let's say that it will happen between the age of 10-12 years. Elite juniors then already play in *green* or *yellow* (TAUT, Play & Stay, Tenniskids).
That seems terrible but it doesn't have to be that way. In this phase a child is making a decision to be more serious about tennis for the first time. MindTennis can perfectly join this choice.

"Stage 2: Refinement/Transitional. *During this phase the athlete evolves into a "serious" player. She no longer wants to just play tennis; she wants to be a good "tennis player".*[153]*"*

That doesn't take away that I would continue to find possibilities to influence children before this age. In order to smoothen the later possible transition. Once in a while you can show every age group rallies in those beautiful yellow lines you also see on television. With a tracking device like *Zenniz* that is very easy to do.
Pure indoctrination is involved in here. No explanation. The kids only need to see the images of those beautiful yellow lines they just made their selves. A kid in a magical phase will carry these images a life time with him. Maybe later on he is going to construct them invisibly like a wizard. I see a lot of potential in this area.

[153] P. Lubbers, D. Gould; Phases of World-Class Player Development; ITF Coaching & Sport Science Review 30 (2003)

Image: *Virtual Reality Glasses*; In the near future kids will be able to walk on a virtual tennis court and see the magical yellow lines besides Roger Federer or Serena Williams.

5. Coaching and MindTennis

MindTennis must be implemented structurally and precise. From one moment in time a player must work out of one idea. Training, playing MindTennis, being coached and play matches all in the same visual language due to the Game Action.

MindTennis will become the language of all the get-togethers. Tennis requires a lot of verbal explanation. So it is very handy to have one clear visual language which you also happen to train. It will take care that coach and player see the exact same image at once.

So MindTennis is not only for players. All coaches and staff members must be able to play MindTennis. Like there are hitting partners you also must be able to play MindTennis at your level with equals. In the beginning phase a player is not allowed to play it with everyone. It is not just a game. It is important to be able to appoint all the necessary Motoric Movement Actions of the Game Action from universal to player specific to opponent specific. Coaches must be well prepared to play MindTennis in an opponent specific way.

It all must form one whole thing. A player trains the Game Action in ball trajectories every day on-court. Plays MindTennis in the same format. Coaches scout their pupils and opponents in the same language and give instructions with the same idea. Especially when they are young players meet many different coaches. All of them with their own language. MindTennis will make it much more uniform.

6. MindTennis and match preparation

MindTennis makes it possible to prepare, to play and to evaluate matches in one language. It ends non-committal attitudes. It makes an end to: "Oh, I just wait till the match starts! And then I see what I have to do." From the first day of the introduction of MindTennis (age 10-12 years) coaches are forced

to mentally prepare players. There is a big profit to be made here in comparison to other junior players.

"At present, mental preparation for tennis play is reserved for elite adult players and is practically non-existent for young hopefuls. Furthermore, in training, motor repetition is generally the only method used by coaches to reinforce learning.[154]"

In preliminary meetings expected game situations must be reviewed thoroughly. When you play against serve specialists it is necessary to visualize the opponent specific incoming ball trajectories of all the services this opponent can perform. Before the match there must be guiding thoughts about the optimal position to make the returns of service. Several match play strategies must be appointed.

"Players and experts are surprised with the fact that nearly 80% of playing time is spent on things other than just hitting the ball to win a point. A lot of time is taken up changing ends, in the intervals between games, between points and thinking.[155]"

Image: Richard Gasquet; *every break a new grip*

Tennis is an outdoor sport for 60-70% of the time. Courts are soon unplayable due to weather conditions. Every player, from competitive to pro, is used to non-playing periods in between matches. Periods you can't actually hit balls. Even in an ongoing match there are many periods of non-playing pauses. MindTennis is able to keep a player focussed. A quick analysis can serve to the good if a player is trained to do so.

A tennis player like Richard Gasquet tries not to think by changing his grip every time there is a break. He wants to stay in a certain zone. Different to Gascuet I want players to gain as much advantage as possible out of these non-playing periods. To evaluate the current situation with MindTennis. What goes well? What not? Where/how do I make adjustments? Do I need to change strategy?

MindTennis is in complete alignment with the Game Action. A player only focusses to the things he really needs to address. The more he focusses to the necessary actions the more flow will appear. Because your mind is occupied in a *good* way it will not be distracted.
Richard Gasquet's grip will definitely not keep him from having thoughts. It is as abstract as looking to just a ball not coupled to a ball trajectory. If you don't give the brain a real functional task to fulfil it

[154] Mental Rehearsal and Learning in Tennis; Simon, V.; ITF Coaching & Sport Science Review Issue 41 (2007)
[155] Tennis is a Mental Game - Part one; D. Samulski; ITF Coaching & Sport Science Review 40 (2006)

will not really be distracted and/or guided. It will see the pink elephant even if you don't want the brain to notice it.
After the match game situations can be evaluated *fresh*. Due to MindTennis and the match preparation the coach and player will be able to point the finger to the recently experienced problems very fast. Issues which need quick addressing can be reviewed on court right away.

7. MindTennis and visualization

MindTennis is first of all centred around the Game Action. The Game Action is completely separated from the technique (Te). However if there is actual hitting the ball trajectories in MindTennis are leading the technique. For consistency a player has the task to just repeat the same movements over and over again. Creativity is banned. For consistency boring repetition is required. To do that a player needs to visualize within his technique the constellation (the image) of his body, racket and racket head in relation to the starting point of the outgoing ball trajectory. The observation of the incoming ball trajectory and the outgoing ball trajectory is important for the global perception but the actual vision of the intersection point and the execution of the Initial Phase are crucial in shaping the actual outgoing ball trajectory. A player needs to gain control over that constellation in order to become consistent. The outgoing ball trajectory is the checking device.
In an example lesson regarding the service I will give more details[156]. The visualization of ball trajectories in MindTennis is used to optimise motoric learning.

"However, the majority of research in this area shows that gestural representation is a decisive tool in the learning process (Bertsch and Le Scanff, 1995). The serve is the most closed tennis stroke and a key motor skill in winning matches. It may therefore be assumed that visualisation work for the serve may be undertaken to facilitate learning and enhance performance.

Contribution of imagery to mental rehearsal Chevalier (1990) demonstrated that imagery makes a significant contribution to acquiring motor skills by using mental rehearsal procedures (Denis, Chevalier and Eloi, 1989). Three main schools of thought seek to account for this phenomenon.

Symbolic theories highlight the cognitive component of mental rehearsal. They attribute its effectiveness to the cognitive processing that accompanies this activity. Accordingly, mental rehearsal is felt to gain its effectiveness from the possibility it provides for the performer to better organise the representation of the situation, of the movement to be performed, and in particular the perceptual cues essential to performing the task (Denis, Chevalier, Eloi, 1989). In short, symbolic theories place a greater emphasis on the cognitive relationship between imagery and mental rehearsal in learning motor skills.[157]"

The Game Action is about Motoric Movement Actions which are built on a cognitive basis. I hope it is clear that MindTennis can be arranged among the *symbolic theories*.

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[156] Chapter 12
[157] Mental Rehearsal and Learning in Tennis; Simon, V.; ITF Coaching & Sport Science Review Issue 41 (2007)

In tennis a lot is written about visualization and imagery. I now discuss one of these presentations[158] in order to further clarify MindTennis. I discuss it point by point.

- *Imagery / Visualisation What to imagine?*

•Recreate specific point sequences to be used in the match: –Playing perfect tennis –Dealing successfully with adversity –Scenarios: •Dream •Nightmare

MindTennis also focusses on the assumed *specific point sequences* which will be the centre of the upcoming match. However it doesn't focus on *perfect tennis* but on *realistic tennis*. The Game Action regards focussing on perfect tennis as reinforcing *self-1*. Often frustrations in players are born out of non-realistic success rates. A player must possess the realistic percentage of a stroke in a game situation. Those percentages must be structurally trained on-court and reviewed with MindTennis. Players evolve from universal statistics to player specific statistics to opponent specific statistics.

When the statistics are realistically and structurally trained a player is able to rely on them. That is a necessity. A player must get convinced that an opponent can be three times lucky but that the statistics contain the truth. Do not change a strategy after three lucky shots. A player must already have gained the experience that sometimes the wind is in your face and sometimes it is in your back. Many considerations led to the strategy you are now performing on court. Because you thought it would be the most successful approach. So at first you need to continue with the primary strategy. If a player is realistically trained he will never get disappointed.

- *Imagery / Visualisation When to use it?*

•Before and after practices and matches: –5 minutes each time –If tennis practice is 5 days a week, then 50 minutes a week of imagery training

MindTennis is a structural thing. You think in ball trajectories. You train ball trajectories. You confer in ball trajectories. You prepare matches in ball trajectories. Every day from the day you became 10-12 years old until the day you finish your career as a pro. There is a world of difference between MindTennis and *5 minutes each time*.

- *Imagery / Visualisation When to use it? •During matches: –Before the serve and the return: Several seconds –During change overs: 10-15 secs. •During personal time •When recovering from injury*

As explained earlier there are a lot of moments when you are not able to actually hit a ball. MindTennis is the structural possibility to visualize match play during these moments. Visualizing the service and the return on service are a structural part of the Game Action. It forms an essential part in tennis. Players must structurally focus on the ball trajectories involved. They must have a wide cognitive basis with all their services and the services they have to face in their matches. It is more a lifelong thing than *10-15 seconds*.
I have witnessed dozens of training sessions at several (>20) tennis academies. If I was responsible for the training I would expand the training of the service and the return on service by a factor four. That says something about my gained vision due to the Game Action but it says a lot more about those academies how they treat these two game situations.

- *Visualise your success. See yourself do it*

[158] Imagery/visualisation for high performance players; M. Crespo & M. Reid; http://www.fedcup.com/media/113945/113945.pdf

There is a lot of writing about this phenomenon. A player has to gain self-confidence. The Game Action can't do anything with it. Like I mentioned before this quote reinforces self-1 and to disturb a player with this will only harm him. Like what's been said before a player must be confident in realistic things. Things he can control and only reinforce the Game Action. A player must be able to look in the mirror in a very honest way and has to find ways from his strength to the weaknesses of his opponent. He must understand that the opponent will also win points. He only needs to come at the good side of the score. Success is a consequence of this approach and can never be a goal in itself.

There is also a lot of research concerning the anticipation of a player to the Motoric Movement Actions of the opponent before he creates the incoming ball trajectory. Every opponent can try to disguise strokes but bit by bit he must reveal his intentions.

"Our perception of the environment and our responsive actions are more directly and intricately related in sports activities than in many other activities of daily living. Temporally constrained situations in many sports demand that players extract the most valuable sources of visual information and use that information to quickly anticipate the opponent's action. A recently published list of the 10 hardest things to do in sports ("Sportsline," 2003) included three sports in which task performance relies on that anticipation. Highly skilled athletes are believed to possess the ability to perceive visual information from an opponent's motion pattern and use that information to anticipate subsequent events. A number of investigators have been interested in that conspicuous ability of expert players and have examined anticipation in activities such as tennis (e.g., Jones & Miles, 1978), hockey (Salmela & Fiorito, 1979), badminton (Abernethy & Russell, 1987), squash (e.g., Abernethy, 1990a), and soccer (e.g., Savelsbergh,Williams, Van der Kamp, & Ward, 2002).[159]

Now players are indeed trained to extract information out of the game situation and especially the preparation and main phase of the swing of the racket in order to make predictions about the future positions of the ball. MindTennis can add the following. Even before you hit your outgoing ball trajectory (OBT^{-1}) you can make a global prediction about the possible intersection points it will give to the opponent. Those intersection points are situated on the same ball trajectory line but differ in time. The option to create a ball trajectory out of a 1st tempo will always be in front of a ball trajectory out of the 2nd tempo.
If this part of MindTennis is added to the already existing forms of anticipation than the picture is complete.

"Welke informatie wordt gebruikt door sporters van verschillend prestatieniveau is bij veel sporten onderzocht. De resultaten laten zien dat door vroegtijdig visuele informatie op te pikken beter geanticipeerd kan worden en er dus meer tijd beschikbaar is voor een adequate actie. Meer tijd is overigens erg relatief; het gaat vaak om milliseconden. De pionier op dit gebied is de Australische onderzoeker Bruce Abernethy, die genoemd verschijnsel onderzocht bij diverse racketsporten, waaronder squash en tennis (Abernethy & Russell, 1987).[160]"

This last point makes a plea for the construction of an image library of opponents with special strokes. For instance opponents with forcing services should be documented. Because the documentation will

[159] The Use of Anticipatory Visual Cues by Highly Skilled Tennis Players; J. Shim, J. Chow, L. Carlton, W. Chae
[160] G. Savelsbergh; Tussen de linies spelen; http://www.fsw.vu.nl/en/Images/Oratie_Prof._Savelsbergh_tcm250-108263.pdf

take a lot of effort I think it must be limited to elite players. The images need to reveal all services in ball trajectories with the specific Motoric Movement Actions of the opponent out of the perspective of the player. A player must be able to consult this image library at any moment. It will make a maximal contribution to his match preparation.

"Cues can be emphasised using film-based training programmes (e.g. Burroughs 1984; Christina, Barresi and Shaffner 1990; Williams and Burwitz 1993) or by highlighting important information during training such that they stand out from background distractions (see Maschette 1980). This latter approach can be achieved by using colour coding schemes to represent key cues. For instance, if the ball toss is an important cue in the tennis serve then an opponent can wear a brightly coloured glove or wristband to draw the learner's attention to this area of the display (ibid.). Similarly, the racket head can be painted with a bright colour so that the learner can easily pick out relevant racket angles as the ball is struck (for further information on improving anticipation in sport, see Abernethy and Wollstein 1989; Maschette 1980; Williams and Davids 1994)."[161]

[161] Williams, A.M., Davids, K., Garrett, J.; Visual Perception and Action in Sport; p. 55

Chapter 12 – The GBA ~ consequences for daily practise ~ *Consistency*

Consistency is one of the classical key factors in tennis. It is one of the level depending factors (LDF). In the old tennis action it stands for the percentage with which a player is able to link one certain incoming ball to one certain outgoing ball. It has a relationship with the technical break point (TBP) of the strokes of a player. The Game Action copies the term with of course the difference that it is now about the percentage in which a player is able to link one certain incoming ball *trajectory* to one certain outgoing ball *trajectory*.
I distinguish two kinds of processes in tennis. Very creative processes and extremely dull, boring non-creative processes. The Tactical Tennis Action is a creative process and will have to provide one specific ball trajectory shape. So the Actual Tennis Action is confronted with a fait accompli. It just has to execute what the Tactical Tennis Action has decided. In that way the Tactical Tennis Action serves the Actual Tennis Action. But on the other hand the Actual Tennis Action just has to execute what has been ordered. Just execute the desired ball trajectory shape in a reliant consistent *dumb* way. Creating consistency is a part of the execution of the Actual Tennis Action.

By the way consistency is never related to hitting safe non-usable ball trajectories towards each other. That is why rallies, which only have the goal to make a long chain (*number*-rallies), must be rejected. The Game Action rejects every exercise with the only goal to connect just any ball trajectory to long chains. You don't train anything of the Game Action by doing so. The counting distracts players, it reinforces *self-1* and it is a wrong way to address the responsibility of the player. It is possible to practice the Actual Tennis Action solely. Players can only train reference ball trajectories and by doing so long chains are likely to occur. But that is a consequence of a completely different goal. Making long chains can never be a goal in itself.

Consistency is connected to the success rate of ball trajectories. Game Intentions, shapes of ball trajectories and success rates have a set correlation with each other. Elite players do have a success rate of 95% in equal rallies from the baseline with round ball trajectories. In a scoring flatter ball trajectory a percentage of 80%. And in a shot-to-nothing a percentage of approximately 20%. So consistency is connected to all strokes. Not only the safe ones.
A coach must be able to appoint all percentages of a player and must be able to compare it with universal percentages. Even if a player only makes one ball trajectory every once in a while a coach must be able to come up with a realistic percentage. And that is also what the player must learn. So a player must stop counting but he must learn to realistically estimate his percentages. In separate Actual Tennis Action training sessions this can be appointed very well.

In match tennis just one ball is important and that is the next incoming ball you are going to hit. As a teacher this is what you have to encourage. The first next ball must be hit with an optimal Game Intention. If you train in that way players learn implicitly and explicitly that making errors is an essence of tennis. A success rate suggests negatively that there is a *failure* rate. If you confront players with these "normal" *failure* rates than players start to think in a realistic way. Then they will accept mistakes. Even after one ball. If a player is raised with *number*-rallies he will not develop a realistic view and will have irrational expectations. Those players will soon show frustration during actual match play.

The Game Action gives new insights to increase consistency. As mentioned before there will be no more room for uncommitted coaches. Coaches must increase the consistency of their players. In this area a lot of problems are noted.

The next quote is exemplary for the daily practise nowadays.

"Kieskubus - Een voorbeeld uit de praktijk:
Je speelt een wedstrijd en je slaat gemiddeld twee dubbelfouten per game. In deze situatie heb je een aantal mogelijkheden: • de wedstrijd "tanken" (onttrekken aan situatie) • Je neemt voor lief dat je dubbelfouten slaat (accepteren) • Je wordt boos op jezelf en begint te schelden (klagen) • Je zoekt een oplossing door bijvoorbeeld de volgende service hoger over het net te slaan. (doen)
In dit voorbeeld heb je dus vier mogelijkheden. Welke zou jij kiezen?"[162]

(Translation red.:) "Choice Cube – An example out of the daily practise:
You play a match and you hit two double faults each service game. In this situation you have a few possibilities: • " To tank" the match (Withdrawal) • You accept the double faults (Acceptation) • You become angry and start to curse (Complaining) • You start to look for a solution (Doing). In this example you have four possibilities. Which one would you choose?"

I see a fifth possibility and that is to file a complaint against the player's coach. If somebody hits two double faults each game than it had to be noticed and be treated in a much earlier phase. Coaches must structurally train consistency.

There is however an incompetence in coaches to address those kinds of problems. It is a general issue. A *fine* example can be seen in Holland (The Netherlands, Europe) in the results of the Dutch elite players.
The men have irregular serve statistics. Last year (2015) Robin Haase had the dubious honor to break the record of most lost linked tiebreaks. He produced significantly more double faults at the end of tiebreaks. At times Igor Sijsling is able to serve at a very high level but at times he also loses it completely. But that is nothing compared to the ladies. I will not mention any name. All the Dutch lady elite players experience the serve as a problem. From just a problem to a very severe problem Every insider knows that.

I did not perform any research and I was not able to structurally look at the matter but I have seen hundreds of hours of training sessions of tennis academies, pro players and their coaches and the Royal Dutch Lawn Tennis Association (KNLTB). All the instructions I have seen were from a technical nature. Of course some players needed technical improvement but I do not believe that they all did. I know they didn't. On a regular basis I did see players aiming at cones and one time I saw a player aiming two centimetres over the net. That is what a top coach asked him to do. The Game Action rejects this all in a very strict way. Ball trajectories are created during the Initial Phase and from there they will automatically go over the net and into the service box.

A player who really struggled with this in the past is Elena Dementieva. I dare to state here that she would have been the number one of the world for a longer time with a more consistent service. Now she was not able to reach that position and I really think it tormented her in not succeeding to take control over that part of the game. Richard Krajicek trained with her a short period[163]. His statements in this video clip prove once more that great players are not the equal of great coaches. She didn't have any problem in producing a good service. Her service met up with the requirements of the ball trajectory defining factors (BTDF) of a good professional service. She had problems with delivering that service on a consistent basis. There is a world of difference there. Richard mentions a lack of confidence. But it had nothing to do with confidence but everything with understanding the task at hand. And she was not the only one. This clip shows again that they tried to solve this with *extra* technical training. Because that was not the issue this help led Elena of course to no improvement whatsoever

[162] http://knltb.nl/siteassets/1.-knltb.nl/downloads/tennissers/jeugdtennis/bjo/informatieboekje-bjo-2015-2016.pdf
[163] https://www.youtube.com/watch?v=_TTDINFF_iE

and she kept on struggling. This is the daily routine you can see with almost all players at the training courts.
You may forget all the names mentioned in the previous paragraph. The multitude of experiences must illustrate that there is a problem. With the Game Action as a guide line I will now show how you should approach consistency. I will do that in an example lesson of the service. It must serve as an example how coaches should treat all strokes in all game situations.

Example lesson consistency in the service.

Drill A1:

1. First the coach and player need to find out if the service meets up with the desired specifications of ball trajectory defining factors (BTDF) of the end form. In this phase the ball trajectory doesn't need to have consistency yet. In this phase it is absolutely not relevant. The only thing important is if the prerequisites of the service have a *future*. If that is not the case one need to start up a process which will guarantee the desired changes. This is an ultimately creative process in which improvements must be researched in a very *open* way.

Image: In the service there is also an incoming ball trajectory. So the whole Game Action must be applied to fulfil this task.

During this phase the movement trajectories get special attention. Right now it is not important if the action trajectory reaches its ideal spot. Although a coach must observe if the relationship with the desired ball trajectory shape remains present. If the new movement trajectories don't allow the shape to come forward anymore the process needs to be reviewed. If the shape isn't right a ball trajectory will never fulfil the expected goals. I often have to convince beginning match players that certain shapes of ball trajectories hardly have a chance to become a valid ball trajectory. And that the chance diminishes the faster they try to hit the ball in that specific ball trajectory shape.

2. When the service complies with the desired specifications the creative process must be stopped completely. Not even a little improvement should be worked on. The *new* movement trajectories will need time to settle in and the focus should almost completely return to the action trajectory. A

player who is confronted every training with tiny technical adjustments will never be able to reach the stage of full consistency. In spite of the good intentions of the coach. If there is need for change than step 1 needs to be repeated. This shows that step 1 must be evaluated thoroughly.

Then the phase starts of increasing the consistency. In comparison with step 1 this is an absolute non-creative process. Consistency is just a matter of repeating motions in a *dumb* way. To not newly discover your service every time you hit it but to hit it again and again in the same way.

So where is consistency in the service? The Game Action is very clear about this. You only are able to influence the ball trajectory during the Initial Phase. The Initial Phase is at the side of server at the baseline. The player needs to be there with his mind and nowhere else. It is for the player strictly forbidden to aim over the net or to hit it to a certain spot. The only thing he has to do is to hit the ball in the ball trajectory during the Initial Phase. In the latent ball trajectory he just visualized before the execution. This ball trajectory will by itself go over the net and into the service box. During the Initial Phase a player hits the ball in the perceptual latent ball trajectory.

In that way a player is going to produce several services. From the services which met the final requirements he has to visualize the Initial Phase he hit and he has to repeat that visualization. It is important that the player will start to see the constellation of the racket head (and/or racket, and/or arm etc.) in relationship to the ball and the Initial Phase of the ball trajectory. That is all. The coach has to help the player out of the player's service and not out of his own service or the service from another player. The coach needs to analyse this movement thoroughly and must reinforce the mentioned visualization process by making the picture more and more concrete to the player. It is not necessary but it helps a lot if a coach has knowledge about which service model[164] a player uses.

"Finally, coaches should attempt to increase awareness of important internal cues related to performance. For example, the appropriate allocation of attention is important to ensure that the relevant feedback is attended to following task execution. A useful technique is to ask the performer what the movement felt like and how well he or she performed. This type of approach constrains the learner to engage in processing movement information and in the self-detection of errors during the period immediately after performance (see Swinnen 1990; Swinnen, Schmidt, Nicholson and Shapiro 1990). That is, it forces the learner to selectively attend to the sensory feedback and to subjectively evaluate it relative to the immediate response. An alternative approach is for the coach to direct the learner's attention towards the most important sensory information prior to movement. Statements requiring learners to concentrate on the feel of the movement are common within coaching practice as they draw explicit reference to the importance of this aspect of the task to skill acquisition. It is therefore important that the coach ensures that the learner focuses on the most significant sources of intrinsic feedback in order to facilitate the learning process."[165]

The Game Action completely contradicts with this quote. The focus on *internal cues* will reinforce *self-1*. The Game Action insists to create a concrete perceptual image of the previous mentioned constellation in relationship to the Initial Phase of the ball trajectory. This concrete image must serve as the image where the stroke must work towards. That image is mainly responsible for consistency.
The technique derives a fixed value from this image. A certain feeling can be allowed during the execution of the technique but that has nothing to do with the *task execution. Internal cues* belong to the technique and not to the task execution. They belong to two incompatible areas which are

[164] Chapter 14.3
[165] Williams, A.M., Davids,K., Garrett, J.; Visual Perception and Action in Sport; p. 55

switched continuously in nowadays coaching. The technique will never contain the action trajectory. The Game Action demands focus on the action trajectory. The ball trajectory. In my book about the Motoric Movement Action[166] this is explained completely.

3. A player can also be supported by investigating how he perceives the moment of the Initial Phase. The sequence of the perception in most players is 1. the ball, 2. the racket head and then 3. the visualization. In this sequence the direct perception of the Initial Phase is from the back side of the racket head. The side that doesn't touch the ball. So the players see the ball leaving from behind the racket.
   Roger Federer perceives it in a different order (see image a). Namely 1. the ball, 2. the visualization and then 3. the racket head. His visualization on the Initial Phase is from the front side of his racket head. Or to say it differently his visualization is in between the ball and the racket head.
   I have seen consistency significantly increase by reinforcing this cue. Probably because for some players it meets reality in a better way.

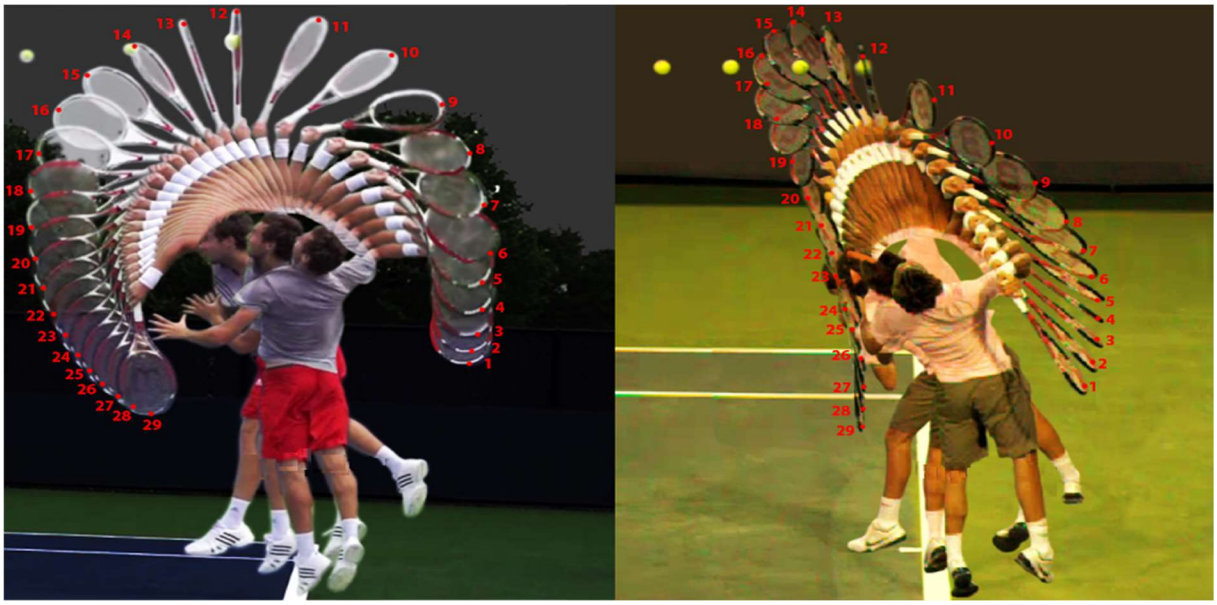


Image a: Till the moment of hitting (number 12 photo on the right side) Federer looks at the starting point of the outgoing ball trajectory. Out of his visualization he sees the racket head coming from *behind* towards this point. Federer visualizes this from the front side of his racket head. With Ernest Gulbis (left photo) this is different. With his visualization he is behind the racket head.

Drill A2 until complete match play.

If the drill A1 is sufficiently incorporated in a player then the Game Action should be trained structurally. A gradual development is needed from closed game situations to full match play. I will now describe all actions the Game Action requires. Flow and playing in the zone will occur if these actions are executed.

1. Before the service a tactical plan must be developed. The outgoing ball trajectory (OBT^{-1}), the outcome of this ball trajectory and the possible incoming ball trajectories must be visualized like in every stroke.

2. The tactical plan leads to only one decision. One execution of a Motoric Movement Action

[166] Caught In A Line ~ *The Motoric Movement Action*; N.J. Mol – january 2016

only leads to one action trajectory. After this choice tennis is not an open skill anymore. The outgoing ball trajectory requires precise execution. The visualization of the outgoing ball trajectory must become leading. This latent ball trajectory will bring the ball over the net into the service box. Now a player only needs to hit the ball into the latent ball trajectory. The only moment a player can do that is during the Initial Phase. It is the only phase he can influence the ball. After this phase the execution phase must be closed completely. A player must not be occupied if the ball is going over the net and/or if the ball is going into the service box. A player only needs to check if the Initial Phase of the actual ball trajectory corresponds with the Initial Phase of the perception of the outgoing ball trajectory. Deviations should be trained structurally. The cognitive basis must come up with tactical alternatives in tenths of seconds when deviations demand it.

3. The main goal remains how the end of the outgoing ball trajectory will be in relationship to the position of the opponent. After the Initial Phase a player should transition to this focus as soon as possible. With the progressing of the outgoing ball trajectory (OBT^{-1}) the predictions of the outcome will grow from global to very precise. This is the same story in all outgoing ball trajectories.

End of example lesson.

The perception (P) dominates the Game Based Approach. It is mainly concerned about the perception processes which serve the cognitive basis. They belong to the *software* of the perception.

"Plainly, sports action requires much more than the ability to 'see'. The apparent paradox of having to see, yet perform competently without being able to see well, has brought about a division of emphasis in research into the role of vision in sporting action. On the one hand, there are those who suppose that performance, particularly in high speed ball games, is a function of the quality of the individual's visual system. On the other hand, there are those who contend that perceptual skill is more a function of the expert knowledge gained through experience than the quality of the system that registers the various signals. The motivation for the second position has been generated by lack of evidence for the suppositions of the first. The two viewpoints are often referred to as 'hardware' (system quality) and 'software' (knowledge structures) perspectives (for an extended discussion, see Abernethy 1987b; Starkes and Deakin 1984; Williams et al. 1992). Specifically, hardware factors are taken to be 'physical differences in the mechanical and optometric properties of the visual system' and software factors as cognitive differences 'in the analysis, selection, coding, retrieval, and general handling of the available visual information' (Abernethy 1987b:8)."[167]

Consistency can also be optimised by improving the *hardware factors*. There are methods to train these hardware factors universally. However questions arise concerning efficiency. For tennis it would be perfect if methods are developed which specifically reinforce the Game Action in tennis.
By the way the *visual hardware* belongs to the technique. They must be ranked under individual conditions or physical processes. The *visual software* belong to the Game Action.

[167] Williams, A.M., Davids,K., Garrett, J.; Visual Perception and Action in Sport; p. 62

Chapter 13 - Technique – An introduction to the *The Inner System*

1. Introduction

The full Game Based Approach is observing the Game Action as the main central idea. The Game Action must be executed with technique (Te). So the technique is glued to the Game Action but it stays on the complete outside. In a formula: GBA = Te x (GA). The formula clearly shows the dependent relationship of the technique towards the Game Action. However it also shows that you can play top tennis with less insight in the game of tennis combined with excellent technique. Even in nowadays tennis one can witness this phenomenon.
The formula shows clearly as well that the Game Based Approach is an arhythmical product of the technique and the Game Action. There for they both need to be optimised.

The substantial side of technique is not the object in this book. This book is about the Game Action which has never been appointed. The Game Action as a complex system can be delivered on paper. That is impossible with technique. The technique follows the same complex system model. Writing down the complex system of the Game Action was already a tough job because all parts have complex relations with all the other parts. A linear description would have been a lot easier. Technique is even more intangible then the Game Action. If you want to understand the relationships in one model you need to go to a court and feel what is being explained. You can't learn that out of a book.
However if it would be possible I wouldn't have given it to you out of commercial reasons. I have worked towards these insights for all of my life. All what I have done brought me to this level and the last ten years I have conducted around 10.000 hours of actual tennis research. I gave you the proof for the full Game Based Approach and the Motoric Movement Action. In my view nobody can accuse me of greediness or being egoistic.

So I won't discuss technique here in a substantial way but I will appoint crucial thoughts which must form the outline for further research. These thoughts will have severe consequences. Research and teaching methods will get a strict framework. Most existing research and methods will have to be rejected.

The full Game Based Approach appoints everything under technique which doesn't belong to the Game Action. So technique beholds everything with which the game is played. Five complex (sub)-systems can be appointed:

a. Individual conditions (IC). IC is the physical ability of a player which he genetically received.
b. Body movements (BM). Except for footwork BM are all the movements a body has to make when the Game Action is executed.
c. Body processes (BP). Under de competence of BP we can arrange all the processes we now consider under conditioning (Co). In my opinion this need not to be changed.

d. Footwork (F). In principle F belongs under BM. However in tennis F has a historical status. In my opinion this need not to be changed. In tennis we recognize court defending footwork (CDF) and ball reaching footwork (BRF).
e. Strokes (S).

Except for individual conditions (IC) all parts are trainable. How a player can train a part depends if one can appoint the part as being linear or complex out of the perspective of the player. Except for footwork all parts must be considered complex systems from that perspective. Footwork can be trained in a linear way. The other parts not.

So technique as a subsystem from the Game Based Approach forms a complex system in itself. In a formula: Te = (IC) x (BM) x (BP) x (F) x (S). Also within the technique one has to optimise the product of all these five processes.

2. Complex system

Strokes (S) are arranged under technique. Technique must be trained as a complex system. That doesn't mean that strokes should be trained as a complex (sub)system as well. Out of the perspective of the player footwork can be approached linearly very well. The same cannot be applied to strokes.

Miguel Crespo[168]: "The purpose of this article is to emphasise the importance of considering and studying tennis learning, coaching and training programs as dynamic complex systems that will help to develop a scientific paradigm of tennis alternative to the actual existing one. Tennis can be considered as an open, interdependent, dynamic, nonlinear, complex and multi-causal system. In order to try to fully understand tennis and tennis coaching it is important to use a systemic thinking approach. This approach takes into consideration the interaction of all relevant variables for the efficient functioning of the system.

Tennis coaching and training has traditionally been dominated by a mechanical concept of the player and the game (i.e. the consideration of the tennis player as a sum of different parts: mind and body; and the notion of the game as composed of different areas: technique, tactics, conditioning, psychology, etc.). This ideological stream, known as "mechanicism", imposed a fragmented and mechanical approach to the perception of the environment, and was originated during the industrial revolution in the 19th Century by emphasising the notion of progress and technological development. This paradigm coupled with the traditional scientific method, which basically assumes that the understanding of the parts of a given system would provide the understanding of the whole, and is also known as "reductionism". As such, this linear reductionist approach requires that the researcher isolates a variable or variables within the system under study for data collection at a specific time. Sport sciences applied to tennis have followed the use of a reductionist philosophy (either deductive or inductive) which has been the predominant paradigm throughout the fields of science for centuries. This approach is a microscopic and not a macroscopic one since it investigates isolated parts of a system. It has also been called a linear (as opposed to non-linear), isolated (as opposed to integrated) and a reductionist (as opposed to holistic) approach. Although the deductive or inductive approaches have contributed to

[168] http://www.tennisicoach.com/en/icoach-experts/Miguel%20Crespo.aspx

our understanding of the game, the results using these classical frameworks and methodologies have shown that it is difficult to understand complex sport behaviour."[169]

However till now strokes are studied and taught in a linear way. Probably the greatest cause in this is the assumption of the linear *kinetic chain* model. This model explains how kinetic energy flows from the ground upwards and from the inside to the outside of the body while performing a stroke. The assumption says that the energy is transferred link by link.

The energy flow of the kinetic chain is unquestionable. There is energy going upwards from the ground to the tip of the racket. However what is questionable is if the energy flow follows the chain link after link. In the continuation I will show that this principle doesn't take account of the actual (complex) situation. I bring the next arguments to the table.

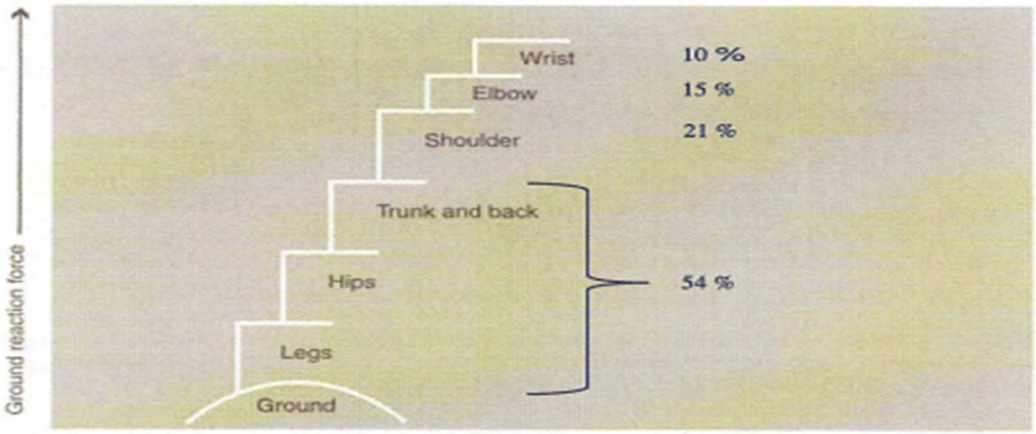


Image: *Kinetic chain* model; *percentages* of link attributions in the service

a. Opposite to this *kinetic chain* model I propose a different theory. In conversations I always explain this as follows. From the very beginning of a stroke to the very end of a stroke your left toe and racket tip *and every body part in between* are moving constantly. As soon as your left toe starts with the service your racket head is going to move as well. And when you hit the service your left toe is still moving[170].

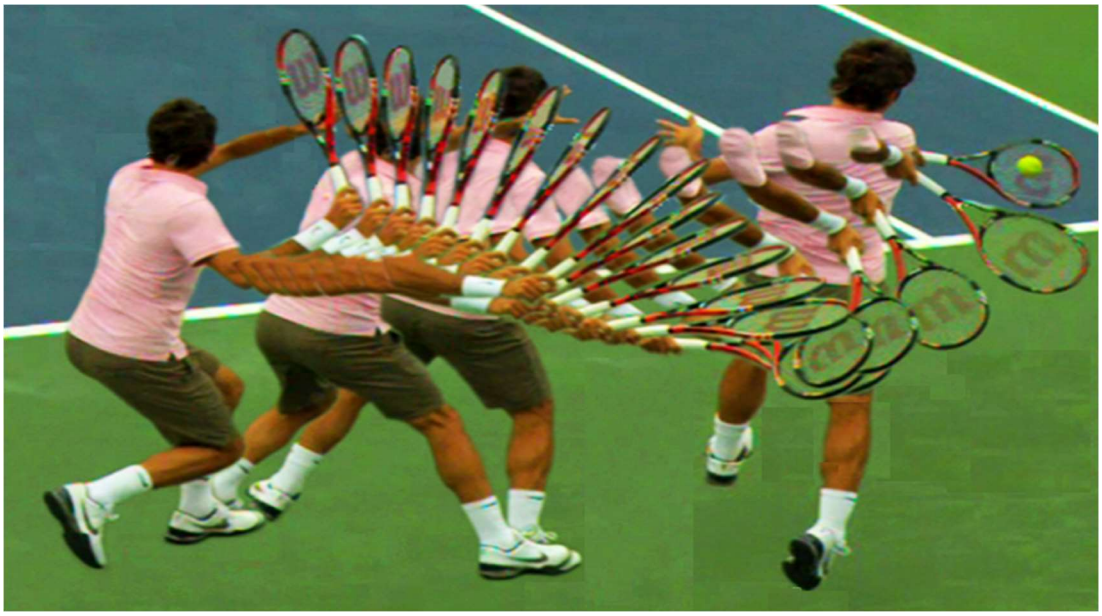
   This theory has a complex system thinking approach as a basis and implies that at least the kinetic chain is not the whole explanation of it all. The whole body is also involved in the whole process. Multiple body parts have set dynamic relations with multiple other body parts although there might be differences in time. Only together they provide the wanted output in one stroke. If one part would not do his job the whole would crumble. Percentages like in the image with the kinetic chain model are there for not relevant.

   The ground reaction force (GRF) is definitely not controlling all body movements. The body as a whole also possesses potential energy. Arms and legs are able to autonomously push themselves of the core. The same push a swimmer experiences when he pushes of the starting

[169] M. Crespo; "Tennis Coaching in the Era of Dynamic Systems"; J Med Sci Tennis 2009; 14(2):20-25
[170] I call it the *unity model*. See *Caught In A Line;* chapter 7 (p. 100).

block. A rigid core with a certain body tension makes that push possible. Think about weightless movements in space. Astronauts don't need gravity and/or ground reaction force to execute Motoric Movement Actions.

In this book you have seen several photos with racket animations. Without words they express what is meant in here. If you would combine the photo with an actual moving image than you can witness the enormous complexity of movements from the beginning to the end of every stroke. Linear explanations just fail.



b. Several bio mechanists have made statements which also confirm that linear explanations are not sufficient anymore:

Bruce Elliott[171]*: However, it is also a difficult stroke to master, as one upper limb must rise slowly to push the ball to an optimal hitting height while the other upper limb and racket must swing in a complex pattern to hit the ball with both power and control. Not only do the arms prescribe different movement patterns and rhythms, but they must coordinate with the movement of the lower limbs and the trunk (Elliott & Kilderry, 1983; Price, 1975).*

Brian Gordon[172]*: "I believe that 3D analysis is necessary to address the critical questions about the forehand, and about all the other strokes as well. This is because the critical movements in tennis happen far too fast for the naked eye to see. Even high-speed video, while visually powerful, gives no insight into how the muscles are actually functioning or a quantitative way to evaluate the differences in the types of strokes".*

c. As a third point I will use an argumentum ad absurdum. Less than 1% of you readers are able to deliver a professional service. A service not only complying to the needed ball trajectory defining factors (BTDF) but also a service which shows a certain harmonic unity. Although

[171] A Three-Dimensional Cinematographic Analysis of the Tennis Serve; B. Elliott, T. Marsh, B. Blanksby
[172] http://www.tennisplayer.net/public/biomechanics/scienceofbio_public.html

most of you have had years of tennis lessons. But only with linear teaching methods. If you happen to possess a professional service it probably has more to do with talent and coincidence. Well you can discuss this. The fact is that the percentage of people able to serve in a professional way is way too small. If the service could be explained linearly than many more people would have been able to serve better and wouldn't it be a lifetime struggle for most of them.

d. I have done participatory research in models of tennis strokes for more than at least seven years. At first I didn't expect to find several models because on the basis of the current bio mechanist view I thought there was only one model. By the way they still think there is only one model. It was only after three or four years that I discovered that pieces of the puzzle gave contradictory information and that they were part of really different puzzles. That fact in itself was a big breakthrough for me. During the same phase I discovered that reinforcing characteristics of one model could be detrimental when reinforced in another model. I remember very well that for one whole year I tried to combine two characteristics of the service which belonged to different models. Naturally it seemed to be pointless.
All the models I found comply with the flow of the kinetic chain. They differ however in the different relationships between all body parts involved. In the next paragraphs I will give more insight in the service models I found.

e. Before I started my participatory research I first examined all the leading bio mechanist research. I combined this with the examination of high speed video clips of all strokes. In 750/500 fps clips you can study every characteristic in ultimate detail. However on-court I couldn't do anything with it. The linear bio mechanist explanations and the outside look of the body movements (*the outer characteristics*) show in an excellent way where to start in a gross motoric way but it doesn't give you any clue how it all works together on the inside. One is blind to *the inner system*. A service contains so many different variables. After a short time you have too many movement possibilities. So the bio mechanical story needs to be translated first. If it was really a linear story than as a professional dancer I would have mastered everything within three months. Now it took me almost ten years.

   "The upper body with a racket was modelled as a linked eleven-segment system consisting of the upper limbs, shoulder girdles, head, upper trunk and the racket."[173]

   Now you can imagine that I frown upon stories that you can learn motoric skills just by watching. My proposition is that nobody can learn the very complicated models in tennis just by watching. You can get a lot of inspiration and you can get gross motoric ideas. These are facts. But the translation to your body is a long and hazardous road. The visible characteristics are on the outside of the body but the unity/the connection is on the inside of the body. This unity is not visible. I call it *The Inner System*. An inner very complicated complex system.

From these thoughts you can understand why the full Game Based Approach approaches tennis technique as one whole instead of five lose parts. *The game is played with technique.* Strokes are just a part of technique. The action trajectory of the movement action (MA) must be appointed dominantly. The action trajectory in tennis is the ball trajectory. A ball trajectory is one action trajectory. The motoric movements (MM) have to be focused much more upon this one action trajectory. That provides a

[173] Koike, S.& Harada, Y.; Dynamic contribution analysis of tennis-serve-motion in consideration of torque generating mode

plea to consider the technique as one as well. In a microscopic way you can recognize a time path where energy is transferred. But in a macroscopic way you could study the whole energy explosion of one stroke for one action trajectory just as one phenomenon.

3. Technique models in tennis

In this paragraph I will appoint the models I found in their relationship to the Game Action. In an era that elite coaches still believe in fast, faster, fastest the elite under the pro players show that their technique found other adaptations to optimise the Game Action. Not that they themselves rationally found different ways but their bodies did. I don't think that any pro player can rationally appoint what they do different than other players. I deduce this from the following. Every time that I made a *discovery* in one of the strokes I immediately tried the same principle in the other strokes. I call that mirroring. To look if and how the same principle would work there. That is how I learned that all principles can be mirrored in all strokes. The elite sometimes possess the principles of one model within one stroke but not in the other strokes. If the pro was aware of what he was doing he would have mirrored a lot more.

The models of tennis strokes are characterized by a basic idea and one leading biomechanical main action. This main action induces the whole process. It determines how and when all other actions takes place. This main action shows which movements are leading and which are *motion-dependent.*

"*The results showed that the rapid elbow extension was primarily due to the upper trunk counterclockwise rotation and shoulder horizontal adduction angular velocity-dependent torques. This study implied that the trunk counterclockwise rotators and shoulder horizontal adductors generate positive torques to maintain the angular velocities of the upper trunk counterclockwise rotation and shoulder horizontal adduction may play a key role in producing the rapid elbow extension."*[174]

I will now appoint how one have to look upon these models and how they can attribute to further development of technique. The service and the forehand serve as examples.

a. The service models

Within the service I talk about models which were found among male pro players (ATP 1-200). They comply all to the set demands concerning the arm action (pronation, internal arm rotation, internal shoulder rotation etc.).
I have found three models. They find their distinctions in the basic idea and/or the biomechanical main action. Besides the model all services contain player specific features.

Model a — This model is characterized by a dominant rotation of the torso as the biomechanical main action. This model is scarcely noticed among pro players. Amateur players use it a lot more. It was the last model I found because I was confronted with the service of Thomas Schoorel (Holland). Also Kenny de Schepper (France) uses the same model. The basic idea is rotation.

[174] K. Naito & T. Maruyama; Contributions of the muscular torques and motion-dependent torques to generate rapid elbow extension during overhand baseball pitching

Model b This model is characterized by a dominant arm action. This is the most used model among pro players. The basic idea is also to gain as much racket head speed due to rotation. In this model the arm provides the main action and the wrist/hand/racket follows this main action in a *motion-dependent* way.

Model c This model is characterized by a combined dominant arm/wrist/hand/racket main action. It is the model of the elite servers. The Movement Idea has nothing to do with rotation. To put that even stronger I can state here that any conscious added rotation is detrimental to this model. The basic idea has a completely different origin.
This is the model of players like Milos Raonic, John Isner, Ivo Karlovic, Andy Roddick and Sam Growth. Unlike what all leading bio mechanical articles state the action of the trunk is *motion-dependent* on the mentioned main action. Like I said before the trunk must not try to add any angular rotation. The passive trunk rotation which will occur is only the consequence of the dominant arm/wrist/hand/racket main action.

The elite model has a few benefits in comparison to the other models. Although the elite model is also the superior model in ball speed that is not the biggest advantage. Players with other models come very close if you focus on ball speed. There is no significant difference there. The real significant differences are situated in other parts.

1. There is a difference in the models in the distance from the biomechanical main action to the creation of the Initial Phase of the ball trajectory. Besides this transition in distance there is a transition in size of the muscle groups that initiates the main action. In the elite model the smallest muscle groups initiate the movement and are the closest to the ball. There are much less *motion-dependent* links left in comparison to the other models between the biomechanical main action and the ball. In the models b and a the distance is respectively bigger and the number of passive links grows. Links which will have to pass all the information anyway. So in respectively the models b and a there is a chance for much more noise at the end of the chain. In model a you can imagine this noise due to the very big dominant muscle groups of the trunk having to pass all the information too much smaller refined links. Although it is much less in model b there is noise there as well as compared to the elite model.

2. Upon the basis of empirical experience I know that there is a significant difference in the quantity of energy needed for one service. When I make a really conservative estimation I say that the elite model only takes half of the energy in comparison to the other models.
If you put 1 and 2 together you can imagine why elite servers can maintain a very constant and high level over five sets. Other models often show signs of falling apart during the 3rd set or sooner.

3. It is very plausible that model a is much more injury sensitive than model b. And that model b is more injury sensitive than model c. The relative gross dominant muscle groups fire the *motion-dependent* refined muscle groups. The much larger forces coerce the small muscles to move because of the main action. The smaller groups are again and again exposed to forces they actually can't handle. In model c this is not the case.
Of course this needs to be scientifically researched. However it is a fact that the day I started serving with model c my chronic golfers elbow *and* tennis elbow disappeared at once.

So in brief this means that the elite model shows a significant improvement in consistency, that it takes significant less energy and that it could be significant less sensitive to injuries. Surprisingly it is not a model with which you can serve faster. A model which you naively would try to find first or where you think that the evolution in tennis would look for *the next step*. It is very important to understand

that not all research must be assigned to fast, faster, fastest. Players show other areas of adaptations which contribute to the optimisation of technique in relation to the Game Action. This will also be the conclusion in the following part about the forehand.

b. The forehand models

In the forehand I only appoint the elite model. The elite model in the forehand follows in great lines the elite model in the service. Unlike what recent biomechanical research claims this model is characterized again by a *motion-dependent* trunk action in comparison to the biomechanical main action. Like what is said earlier there need to be as less consciousness trunk rotation as possible. It is detrimental to the basic idea. The trunk rotation that occurs is the passive consequence of the leading arm and racket action. The basic idea is not built on angular rotation at all.

A difference with the service is that the Movement Idea can be used in two directions in the forehand. It can be used in the longitude and in the width of the court. Robin Sőderling and Juan Martin Del Potro are two examples of players who use it in the longitude of the court. Surprisingly the earlier mentioned Thomas Schoorel belongs to the same group. He not only hits his forehand like this but also his single handed backhand has the same basic idea. Like I said earlier Thomas didn't *mirror* this principle into his service. In the service he uses the most inferior model.

I want to discuss the elite model in the width of the court into more detail. It is the model of the ATP elite (Nadal, Federer, Djokovic and Murray). From retired players I definitely could establish that Steffi Graf used the same model in all her forehands and that Andre Agassi used it in the returns on service. I have the suspicion that Sjeng Schalken (former ATP top 10) used the same principles. Research is hampered by the fact that there is only few high speed footage of their eras as players.

Like the conclusion in the service the greatest significant advantage is not situated in the ball speed. However Del Potro and Sőderling can be reckoned among the *hard-hitters* other models have an equal outcome considering ball speed. Like in the service the significant differences are situated in other areas which also confirm the existence of the Game Action.

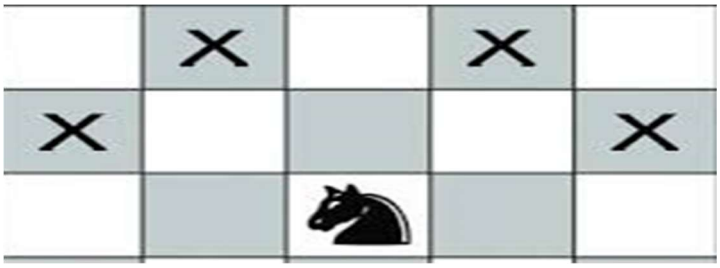


Image: The movement of the knight in chess; elite players are able to approach the ball as the x's closest to both sides of this page. Conventional player need to come behind the ball as the two x's closest to the top of this page.

In the elite model of the forehand in the width of the court the biomechanical main action of the motoric movement (MM) has the same direction as the movement action with the feet. In all other models those are two different trajectories. In the elite model that is only one line. One of the consequences is that a player need not come *behind* the ball like in other models. You can compare it with the jump of the knight in chess. The elite player can stay a knight's jump side wards and conventional players must stay a knight's jump behind the ball. If you combine these facts you can see that elite players have at

least 1,5 meters more reach to either side in the width of the court. If you count that a single's court is 8,23 meters in width 1,5 meters is a very substantial number. A player who possesses this model can't be beaten in the width of the court. And that is what the top 4 ATP prove every match they are playing.

So again the body of these elite players didn't find a solution in fast, faster, fastest but a solution to continue the chain of ball trajectories out of a much larger zone while maintaining good power. You can very well see that the mentioned elite players excel in continuing the chain. Their return percentages are also the highest percentages you can find. Opponents who attack have to take a risk each time they try to force something while the ball is coming back each time. In the end this risk on risk is doomed to failure. If people would know that it is because of a different model than it seems unfair.

An important lesson to be learned from the acknowledgement of models is that coaches actually first need to know which model a player is using. If you reinforce a characteristic without knowing the model that can seriously harm the existing model.
A lot of biomechanical research will need a closer look because of the found models. I compare this with how they looked upon cancer in the past. There were days that they only considered one type of cancer. Now we know so much more about all types, subtypes etc.. Maybe now you can imagine my sceptic look upon the outcome of research that put all service models together. Percentages which you can also see in the image above of the kinetic chain only have global value if you realize that there are several really different models. I rather prefer research done within one model. I hope that alone the mentioned thought that there could be more models will cause the same revelation to those researchers as it did to me.

I need to add in here that not all players execute all models as *clean* as possible. If a model became obvious to me I was able to appoint the ultimate model. In the service Milos Raonic is the only player who executes the model in the most perfect way. Steffi Graf and Nadal come closest to the ultimate model of the forehand. Till now I explain *the noise* in strokes of other players that their bodies found the new principles but that the body also carries *old instruction* of tennis lessons from the past. You can see this strongly in the forehand that the racket has to end over the shoulder. Youngsters are pestered with this instruction. Steffi Graf's forehand never finishes over the shoulder. By some insiders she is still mentioned as having the best forehand ever. The mentioned players probably found a way between that old instruction and the technique their bodies found themselves. I hope that it will be a lesson for future coaches. That they will give a chance to evolution and to functionality of a stroke.

4. Technique models and action trajectories in general

In short I will appoint in this paragraph a few essences which I extensively discuss in my book about the Motoric Movement Action[175].

Tennis contains very specific and maybe the hardest Motoric Movement Actions. However they are complicated they follow all Motoric Movement Actions in exact the same way. Not only in all sports but also in all our daily activities. The explanation as a complex system holds under all circumstances in all Motoric Movement Actions (MMA).

[175] Caught In A Line ~ *The Motoric Movement Action*; N.J. Mol -january 2017

In daily activities you only have to use other words unless you see everything as a game. The task at hand is than the product of the Motoric Movement (MM) and the Movement Action (MA). In a formula: MMA= MM x (MA). That is equal to GBA = Te x (GA).
So the Motoric Movement Action can be divided in the Motoric Movement(s) and the Movement Action. There is a big difference in the lines/trajectories of the Motoric Movements and the Movement Actions. Within the Movement Action there is an action trajectory and in the Motoric Movement there are movement trajectories.
In tennis the technique (MM) has nothing to do with the Game Action (MA). To actually fulfil a task technique is glued to it in a dependent role. The trajectories follow the same separation. The action trajectory has nothing to do with the movement trajectory. A lot of mistakes occur in this part. I will explain that.

The Movement Action like the Game Action only describes the processes which must be involved in the process and not the execution of it. Review the Game Idea for that matter. The Game Action explains the game not the playing of it. So there needs to be a cognitive basis. The cognitive basis forms the blueprint during the actual execution for the tactical (tactical motoric action) and actual (actual motoric action) actions. Within the actual motoric action the perception processing processes towards the ventral and dorsal stream are active.
How it is executed, which action trajectory is executed with what technique, has to do with efficiency/effectiveness and nothing with the action itself. The Movement Action only appoints the necessary actions and doesn't interfere in any way with how efficient/effective a Motoric Movement Action is executed. That solely belongs to the technique (Te) or the Motoric Movements (MM).

The Movement Action (MA) always hosts only one action trajectory. Within the Motoric Movement (MM) one can establish trajectories/lines as well. Every moving body part is *caught in a line* as well. Just like the mutual relationship of the ball and its ball trajectory. If you look upon technique as a complex system than you see that there is not one movement trajectory but always many movement trajectories.
Nowadays there is still confusion about all these trajectories. Also in the scientific world. The appointing of trajectories in this way will take away all that confusion.

The line that actually fulfils the task of a Movement Action is the action trajectory. The action trajectory of posting a letter is the line from the letter to the slit of the mailbox. The action trajectory in rowing is to bring a boat from A to B in a straight line. The Game Idea is to make that action trajectory in less time than your opponents. The game dualism is indirect. The action trajectories in tennis are the ball trajectories. The Game Idea in tennis is to add another ball trajectory to an incoming ball trajectory and to prevent the opponent from doing so. The game dualism is direct.
The action trajectory belongs to the Game Idea or the Action Idea. The movement trajectories belong to the execution of the Game Idea/action idea. They have their own Movement Model with its own Movement Idea.

To really complicate things I will also describe Motoric Movement Actions with just body parts. Like switching on the light or running. In pressing a light switch the action trajectory runs from the sole small tip *on the outside* of the index finger towards the little area of the switch what needs to be pressed. Although it is part of the body the *outside* of the tip of the index finger doesn't move itself. It is moved by other parts on the *inside* of the body with independent movement trajectories. Again there is no relationship between the movements (movement trajectories) and the action trajectory. The same can be applied to running. The trunk/the whole body is like a boat in rowing. It fulfils the action trajectory. The legs mainly make the movement trajectories to make the action trajectory possible.

The movement trajectories are an important part of the technique models. As stated before every moving body part makes a movement trajectory. At a micro level one can distinguish hundreds of movement trajectories within one Motoric Movement Action.
A rower has the aforementioned action trajectory. Within the technique of a rower the push of the legs (against the footboard) and the pull of the arm (of the oar) are obvious outer characteristics of two really different movement trajectories. And they obviously differ with the action trajectory.
Within the technique many inner and outer movement trajectories can be distinguished. Coaches and scientists have to research the many relation possibilities which all these movement trajectories are able to have with each other as part of a complex system. Within every technique one has to come up with at least one full model with one basic (movement) action idea. The model has to appoint all relevant relationships between the relevant movement trajectories. For instance it is important to know whether movements are leading or if they are motion-dependent. Most of the time the (movement) action idea appoints those movement trajectories which embed the biomechanical main action. The biomechanical main action is initiating the whole Movement Action.

So an important conclusion is that the action trajectory is only one line and that there is no relation with the movement trajectories. They belong to two irreconcilable worlds. I will also maintain this line of thought in my book about the Motoric Movement Action about for example walking and the high jump. The legs move the trunk/the whole body. They follow the same principles as in rowing, biking, driving a car etc..
The Motoric Movement always contain several movement trajectories and out of the dynamic thinking approach they have complex relationships with all other movement trajectories. Set correlations between movement trajectories with a basic action idea is called a model.

Furthermore I state that if there is a simple action trajectory involved like in rowing it is less important to have knowledge about the action trajectory. One is able to row extremely fast if one focusses mainly on the technique. If one has just a little understanding where to go. And with a helmsman in the boat that is even not necessary. In tennis the action trajectory belongs to the top of most complicated action trajectories. As a mere mortal it is not possible to play tennis without knowledge of those action trajectories. Even if a movement trajectory demands a little too much attention over the execution of an action trajectory that can have a major negative influence on the outcome of the game.
For all Motoric Movement Actions *flow* and *playing in the zone* only occur if a player mainly focusses on the action trajectory. Partial conscious focus on movement trajectories can be admitted if there is an obvious dependent relationship with the action trajectory. That is why we can press a light switch, post a letter or tie our shoelaces in (pure) flow. We totally focus on the action trajectory and not on the movement trajectories with which we execute it.

So one action trajectory belongs to one Motoric Movement Action. I must add a remark here. The action trajectory in throwing or catching tasks, like in tennis, is an example of one obvious Motoric Movement Action. The action trajectory is one clear ball trajectory with a beginning and an end. In other Motoric Movement Actions where the action trajectory can be influenced every time unit, like in posting a letter or rowing, one could at a micro level divide the task action in many more action trajectories. In rowing it seems logical to define every new stroke as the beginning of a new Motoric Movement Action. In running every step could be seen as a new Motoric Movement Action. It depends on what one wants to research and at what level. However it doesn't matter how you divide it one Motoric Movement Action has one action trajectory. So if you want to divide one step (in running) in thousand pieces than there are thousand action trajectories. However then the question needs to be asked and answered if it makes sense. If one would research a jump from a free diver with a backflip and several summersaults then it is very probable that there are several moments within one dive to start new Motoric Movement Actions. In my view these are the practical moments when new Motoric Movement Actions occur. In a jump from the ten meter board there could exist ten linked Motoric

Movement Actions with ten linked action trajectories. This linking fits the Game Idea in golf[176]. The Game Idea in golf is to connect ball trajectories to a chain without seeing a player and/or technique. The ultimate goal in golf is to use only one action trajectory for every hole. In reality several linked action trajectories will be needed. In the same way a bob sleigher links all the demanded separate different Motoric Movement Actions to one whole picture. The whole picture is needed at the macro level to complete the entire run[177]. In bob sleighing one missed action trajectory will be disastrous.

"Over the past 15 years, research on focus of attention has consistently demonstrated that an external focus (i.e., on the movement effect) enhances motor performance and learning relative to an internal focus (i.e., on body movements)."

"The enhancements in motor performance and learning through the adoption of an external relative to an internal focus of attention are now well established. The breadth of this effect is reflected in its generalizability to different skills, levels of expertise, and populations, as well as its impact on both the effectiveness and efficiency of performance."[178]

When we post a letter, switch on the light or tie our shoelaces we never ask a question about the effectiveness/efficiency of the movement. We learn one way of doing it and stick to it all our lives. If it fulfils the task we are very relaxed as whether the movement is effective/efficient or not. That is understandable. Recently I was attended to this phenomenon when I was confronted with pre-school children who learned to tie their shoes in a different way than I did. I tried the new way[179] but I didn't get it. The action trajectory of that new Motoric Movement Action didn't make a cognitive connection in my brain. And I left it like that. I tie my shoes in my own way.
Of course that is a different story in sports. In sports questions about effectivity/efficiency are raised every moment. One percent profit will take care of a fraction of improvement of the whole Motoric Movement Action. So in sports one needs to implement an ongoing research towards technique models. The Game Action is explained completely. It will never need any more research. Technique models will never be complete. There will always appear somebody who changes the Straddle technique to the Fosbury flop. Like once was the case in the high jump.

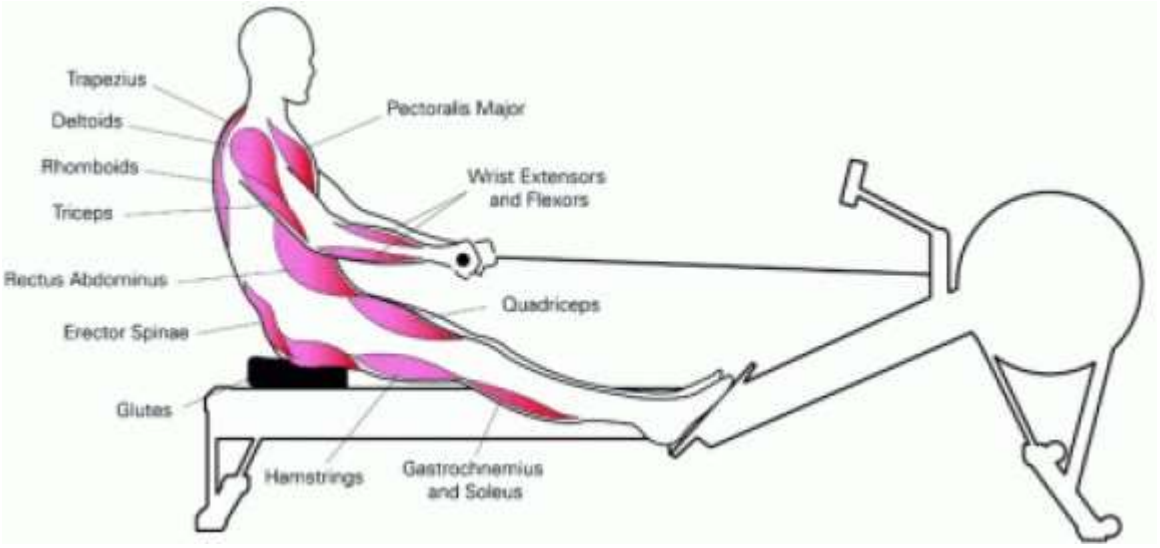
Image: The high jump; Straddle technique (left) versus Fosbury flop technique (right)

[176] See chapter 3 par. 6-2
[177] https://www.youtube.com/watch?v=rHGWZaMzY1I
[178] Attentional focus and motor learning: a review of 15 years; Gabriele Wulf
[179] https://www.youtube.com/watch?v=_aAeI7p-Tkc

Researchers continuously will have to examine elite players and *borrow*[180] what they do. They have to map the new information and really will have to execute the techniques themselves. Participatory research is really needed in there. That is not the prerogative of social sciences only. Besides that coaches/researchers need to keep a careful eye on the tendencies of the bodies of arriving talents. The body itself is also looking for better ways to execute the same task a next time.

5. Technique in general

Out of a dynamical systems approach the needed technique, the Motoric Movement (MM), consists of many movement trajectories. Every moving body part makes a line as well. For spectators these lines are obvious to be seen on the outside of an athlete. However the root of that outward characteristic is on the inside of the body. Muscle groups make all kinds of movements on the inside which will give *motion-dependent* consequences on the outside of the body. All those inner movement trajectories need to have one source. The body must form one whole in executing one Motoric Movement Action. Only if it forms one whole we can call the movements a technique. So a technique is more than just a number of random movements. The technique most probably evolved out of the experience of being effective while being efficient.



If you want to post a letter the trunk and legs will have to form a steady rigid base for the arm to be launched. If you don't do that you could experience what a swimmer would if the starting block would move backwards at the start. That same swimmer needs to have a certain tension in his body when he makes a start and dives into the water with a certain angle of inclination. While swimming the trunk/body needs to form a solid base for the arms and legs to push off. In that way the trunk/body also creates a unity.
This is like in professional dance education programs. One of the most important parts of their curriculum is to let dancers move from their *centre*. All movements need to find their origin in the trunk/body and must form a whole. In dance we call that fluidity. If a dancer needs to only move his fingers in a choreography his whole body must be behind it. You can compare it with an uppercut from a boxer. In

[180] Where I live we just call that *stealing*. But it is *stealing* for the sake of science.

box training you learn how to get your body behind the hit. It makes a real difference if a professional boxer puts his body weight behind it or if he only makes the arm movement. I wouldn't make a too loud request to experience that in the presence of a boxer.

If the body forms one whole in a Motoric Movement Action then people call it a technique. I have no objections to that. I also use the term model or technique model. Within the high jump the Straddle and the Fosbury flop are considered as two different techniques. Probably because their *outer look* is really different. The service in tennis however is regarded as one technique. Yet the elite model is as different from the other models as the Straddle is different to the Fosbury flop. Maybe because the outside looks the same and the emphasis is put more to the *inner look* the term model is better. If one would emphasize the action trajectory in the high jump then the Straddle and the Fosbury flop are not two different techniques but two different models which have the same task.

6. Motoric learning and game optimisation

In coaching athletes we want to optimise at least two things. The effectiveness/efficiency of the motoric learning process and the effectiveness/efficiency of the execution of the Game Idea. This book has given the ultimate answers in relation to these two areas. In short I will review the relevant factors in this paragraph with slightly other words and a possible extra philosophical consideration.

There are three crucial parts. The first two parts have to do with the essences of the Motoric Movement Action itself. The Motoric Movement Action can be split in the Motoric Movement (MM) and the Movement Action (MA). The Movement Action explains the action trajectory and the action idea. The Motoric Movement has to execute the Movement Action. The third crucial part is that the unique body of an athlete needs to incorporate all this. The Motoric Movement Action must be brought to the *subject*. This *subjective* phase is as essential as the other phases. Coaches are able to teach everything and players are able to understand everything rationally but the body needs to understand it as well. That body will finally have to execute it.
This last part is already accepted worldwide. We give pre-school children time to practise to tie their shoes and in tennis lessons we allow our pupils to incorporate everything we tell them. But when it comes down to efficiency/effectiveness there are a few things coaches worldwide don't take into consideration. Coaches mainly reinforce what they think is effective/efficient. They don't even consider to look at the unique individual conditions (IC) of the unique body of the player at hand.

The three parts form an almost complete list. There needs to be worked on technical aspects like fitness, footwork etc. as well. I will ignore these in this paragraph. I will only appoint those factors which are very important for the game and show a great contrast with the standard in nowadays coaching. All the three crucial fields need to be respected equally. Ignoring one field is detrimental for the final outcome.

a. The Game Action

The Game Action is the explanation of the Movement Action as a part of the Motoric Movement Action.
If a player can link the *why* of a stroke to the *how* of a stroke then the effectiveness of the motoric learning increases. Scientific research already proved that. It is one of the main goals of the current education programs. The Technique Approach only reinforced the *how*. In the (old) Game Based Approach the technique is tied to tactics. Tactics must always precede technique. A pupil first

needs to understand why he has to make a certain stroke. So in my training to become an A-level coach I learned to teach the *why* to my students. But the substantial *why* I learned in my training differs tremendously with the *why* my book uncovers.
The more the why is answered conform the truth the more effective the motoric learning will be. The ratio judges but the body also feels if things are right or wrong. The Game Action is the full and definite explanation of the game. It appoints exactly what a player must do and exactly what he must not do. No player will be able to doubt this explanation of the game and will gradually experience it as the only natural thing to do. The *manual* of the Game Action will automatically create flow and playing in the zone. A feeling that you are completely absorbed into the game and nothing more than the game.

The description of the Game Action is complete. Nothing can be added anymore. Instead it created a huge pile of work what needs to be done. To learn how to hit and apply all those hundreds of reference ball trajectories is something completely different compared to that silly line a rowing boat has to create.
So a lot of work needs to be done. But now at least the Game Action formulated an ending list. This is in great contrast with the attitude nowadays that tennis must be approached as a form of art and that the successful execution is mainly dependent on if you have or don't have *the gift*. Especially if you as a player have *it* is a strong common believe among coaches. This question is never turned around towards the coach. If he has *it*. By the way what the gift really is, is never really explained.
The Game Action makes an end to all this and shows exactly what needs to be trained. It makes an end to all those *lazy artists* and provides a tool to all those players who at first didn't possess the gift. The Game Action shows a road to success that you are able to achieve by working immensely hard. Coaches don't need to develop *the why* any further. They only have to put in there the same effort the Game Action demands from the player. There is tremendous work to be done to equip a player with the Game Action. In first a universal way. Then a player specific way. And finally an opponent specific way.

b. Technique models

Technique models explain the Motoric Movement as a part of the Motoric Movement Action.

Coaches need to know everything about models of technique. Obvious superior elite models need to prevail over other models. Superior models will give superior results. Equal models need to be selected after a careful player specific assessment. There is still a debate going on among coaches whether to equip a player with a one handed backhand or a two handed backhand.
Coaches have to get input from 1. science, 2. current elite players and 3. the tendencies of the bodies of their pupils. In comparison with the Game Action technique models will never be finished. The body/humans will always come up with new adaptations. Coaches need to be open to this process their whole career. Open to the fact that there are more models than only one and that it is a process of evolution. I dare to state here that the majority of coaches will have great difficulties with this. A top coach needs to develop a much more objective look towards *subjective* development.
Worldwide I think that only a few coaches will have any understanding with what I mean with models. Probably it is only fragmented knowledge. There is much work to be done in this area.

c. The process of incorporation.

The phase of incorporation, the *subjective* phase, is the crucial factor when pupils need to apply the Movement Action and the Motoric Movement. It is the motoric learning process *of the body*. If a player knows everything about the Game Action and the technique model the body of the player needs to become owner of this all. The body needs to get the time and room to translate it *subjectively*. A coach needs to respect this but especially the player needs to be convinced to respect that process. The body also sorts and supports independent from any ratio. I will not really go into detail but I would like to mention three examples of this natural arranging process.

1. Most of you are familiar with strength training and the term super compensation. Strength training is provoking the body to produce more muscle mass in order to fulfil the same tasks more easily the next time. That is called compensation. If one chooses a certain optimum in the recovery phase to train again than the production of muscle mass is enlarged. That is called super compensation
   It is an obvious example of the body thinking along independently in optimising the task. The athlete doesn't have to make a conscious effort to help in these processes. The athlete only needs to give room to his body to fulfil that task. He needs to rest and eat good proteins. The body does the rest.

2. One of the first research papers I read and intrigued me heavily was *Sleep and the Time Course of Motor Skill Learning* by M. Walker et al..

   "Growing evidence suggests that sleep plays an important role in the process of procedural learning. Most recently, sleep has been implicated in the continued development of motor-skill learning following initial acquisition. However, the temporal evolution of motor learning before and after sleep, the effects of different training regimens, and the long-term development of motor learning across multiple nights of sleep remain unknown. Here, we report data for subjects trained and retested on a sequential finger-tapping task across multiple days. The findings demonstrate firstly that following initial training, small practice-dependent improvements are possible before, but not following the large practice-independent gains that develop across a night of sleep. Secondly, doubling the quantity of initial training does not alter the amount of subsequent sleep-dependent learning that develops overnight. Thirdly, the amount of sleep-dependent learning does not correlate with the amount of practice-dependent learning achieved during training, suggesting the existence of two discrete motor-learning processes. Finally, whereas the majority of sleep-dependent motor-skill learning develops during the first night of sleep following training, additional nights of sleep still offer continued improvements."[181]

   The research shows significant differences in effectivity of motoric learning after breaks with and without sleep. At the time I read this it really struck me. I thought it was a highly remarkable outcome. Motoric learning by doing nothing. The research sadly didn't come up with a conclusive scientific explanation.

   My proposition about the technique (Motoric Movement) as a complex system with its many movement trajectories could form a part of that explanation. All new movement trajectories of a new technique must form complex relationships with all other movement trajectories. Whether new or old. The body has to combine it to one whole again. Like in the super compensation the body has a large independent role in this task. Why especially sleep is contributing more to this process is something I can't answer. However it shows me that a player doesn't need to have a rational willingness to achieve more effective movements.

[181] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC202318/

3. As the last example I would like to mention the research papers of the German professor Wolfgang Schöllhorn. Schöllhorn is the advocate of what he calls differential learning. In exercises athletes must not try to reduce their variations in their movements until a sort of optimum is reached. Repetition exercises and technique training hold on strongly to this adagio. Schöllhorn assumes that our locomotor system will learn by doing just the opposite of technique training and repetition exercises. He gives assignments to athletes to make all kinds of funny/strange moves before they actually perform their *real* technique. Schöllhorn leaves the original action trajectory unharmed. He just reinforces real different Motoric Movements. Within the current culture of sports this would be seen as extremely weird. But the results are remarkable positive. His view is supported by several sports scientists.

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"For numerous skills, it has been shown that many repetitions are needed in order to achieve perfection. For instance, the classic Crossman learning study (1959) of cigar-making indicated that even after 1 million repetitions of this skill, improvement was still possible, that is, a quicker time could be achieved. The common idea of learning is to repeat a particular movement as much as possible, accompanied with feedback from an expert. The desired outcome is based on an ideal movement pattern."

"The Russian neuroscientist Bernstein (1967) noted that consecutive movements never repeat themselves exactly. He made cyclograms of rhythmic movements of an experienced smith who used his hammer on a stationary photographic plate. Bernstein discovered that every movement repetition was slightly different from the next. In other words, even in a relatively simple task such as hammering, the movements produced were never exactly the same (Bernstein, 1967). In sport, most tasks are complex with coaches and athletes repeating the desired movements a number of times in practice in order to improve the performance outcome. Ericsson (2005) described this as follows: "The crucial factor leading to continued improvement and attainment of expert performance is the engagement in special practice activities that allow performers to improve specific aspects of their performance with problem solving and through repetitions with feedback" (Ericsson, 2005, p 237). Underlying this definition is the assumption that there is an ideal way of performing a skill that applies to everybody. Second, any deviation from the required ideal performance is considered as an error (Schöllhorn et al., 2006).
Inspired by Bernstein's hammering example, Schöllhorn investigated whether elite athletes could produce precisely the same movement twice. He studied two elite discus throwers and concluded that during a one-year period, the athletes did not produce the same throw twice (Schöllhorn, 2000), revealing highly individual characteristics of movement (Schöllhorn & Bauer, 1998; Schöllhorn, Nigg, Stefanyshyn, & Liu, 2002). For instance, Schöllhorn and Bauer (1998) were able to identify individual throwing patterns in world class javelin throwers, even across several years of championship experience. Evidence for a larger variability of international throwing patterns in comparison to national throwing techniques led him to question the idea of a person independent ideal technique."

"Therefore, it is not logical to believe in one optimal motor pattern to which all learners should aspire. Based on these findings, Schöllhorn (1999) suggested a learning theory that opposes the repetition of movement based on an ideal movement pattern: differencial learning. Differencial learning utilizes the fluctuations in human motor behaviour to induce a self-organising process to the learner that takes advantage of individual movement and learning characteristics. Therefore, during the acquisition phase, the learner is confronted with a variety of exercises that extend the whole range of possible solutions for a specific task. In other words, an athlete should practice a particular skill in many different ways, and as a result,

> *s/he will discover an individually specific optimal way for her/him to perform the particular skill."*[182]

Wolfgang Schöllhorn's research completely corresponds with the *subjective* phase I suggest. I will not go into detail. Motoric learning is not a part of this book. Although I want to make two remarks.
The first remark is about Schöllhorn's *arranging process.* This process obviously can't replace the two other crucial phases. There is no room for or/or but it must be and/and. At the work floor you sometimes hear that differential learning can cause all the motoric learning. That will never work. If you would only emphasize the subjective phase it would take a really long time before you created a pro player. If you look at effectiveness the first two phases are contributing the highest percentage. However Schöllhorn's findings are crucial to optimise the effectivity of the subjective phase.

The second remark is about the fact that Schöllhorn never changes the action trajectories. He doesn't vary with the line of the task action. It is remarkable because other research consciously aims at changing these action trajectories. So nowadays at the tennis court you can see players serve from the most bizarre places. The goal is to guide the body in a *constraints led* way. Because this book reveals the essential differences between these two forms for the first time new scientific research has to appoint how they relate towards each other and how they relate towards *The Inner System*. Till now I don't have any thoughts about this.

[182] A new method to learn to start in speed skating: A differencial learning approach; G. Savelsbergh, W. Kamper, J. Rabius, J. de Koning and W. Schöllhorn

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