Advanced ISSF Rapid Fire Pistol, Video analysis of High Performance (Version 2)

Tony Anderson, PhD

Video of the methods used to shoot the ISSF Rapid Fire event by six elite competitors who have gold or silver medals from the Olympic or Commonwealth Games, was analysed to show what they did in common. (The video used in the analysis is on the USB Flash Drive). The results show the importance elite competitors gave to setting stance and balance before addressing the targets, dwelling on the first target to check aim and position immediately prior to the call "attention", stopping on each target before firing, firing the first shot in the 4-second series in 1.5 seconds, and following-through by firing an imaginary six target. The analysis covers the warm-up, stance, how the competitors approached the lift, developing a fast lift, rotation across the five targets, the importance setting up the trigger for "feel", and developing concentration skills. A training plan based on the findings is included making the analysis an educational resource sufficiently complete to be used at home without a coach, empowering users to be self-directed' in deciding what information to seek, e.g., from a coach. The program can be presented by a coach in a seminar setting and a Seminar Plan for that is included. The program can be used as a Distance Education tool, disseminating information for the cost of a Flash Drive and postage, nationally. The program design could also be adapted to other shooting disciplines.

Participants in the study

The competitors were, Ralf Schumann (GER), Five Olympic medals, three Gold); Emil Milev USA): Olympic Silver Medal), Christian Reitz (GER): Olympic Gold Medal, and achieved World No.1 Rank; Keith Sanderson (USA): Olympic Record for the Qualification round (583); Sergei Evglevski (AUS). Commonwealth Games Silver Medal and Australian Champion 2022; and David Chapman, Commonwealth Games Gold Medal and many times Australian Champion.

The warm-up

The Rapid Fire Pistol event requires precise movements to fire accurately, within tight time constraints, at five targets. This requires highly developed skills that have been made automatic through practice; excellent balance and core body strength for precise rotation of the body around its centre of mass; the ability to coordinate aiming and to time smooth trigger action to occur in the fleeting moment that the sights are centred; and fierce concentration.

For that part of the warm-up which is conducted away from the firing line, prior to the match, there appear to be three purposes: preparing the body for the actions to be performed in the competition: giving reassurance that the hold, traverse and trigger action are good; and, importantly, beginning the transition into the level of concentration needed for high-performance. The video shows that competitors' warm-up by doing what they have to do in the competition but at a much more relaxed pace. They practised the lift and the traverse across imaginary targets, stopping on each and dry-firing.

In competition: Common patterns in technique

On the firing line, they all practiced traversing across the targets, without holding the pistol, stopping on each and firing an imaginary shot. Positioning the sights on the centre of each target lends itself to visualising the sights perfectly centred on each target, recoiling as if a shot is being fired, as practised

by Evglevski, (2022). The empty hand exercise brings into play the muscles of the centre core of the body which help precise rotation across the targets (Evglevski, 2022). It is a low energy expenditure manoeuvre favoured when on the firing line by the elite competitors observed, to conserve energy for what counts.

They all stood upright, established a well-balanced position, with the body immobile prior to the lift They addressed either Target 1, Target 3 (Schumann, though he is said to have changed his style many times) and Target 5 rarely, except in the Finals of the Match where, with only 15 seconds available to insert the magazine and check that a round is chambered, some shooters address Target 5 then sweep back to Target 1 and dwell. Importantly, in the qualification round, Target 1 received most of their time prior to the call "attention".

At the call "attention" the competitors had already finished aiming at Target 1 and were ready to calmly and steadily lower the pistol. This minimised the time spent standing with the pistol lowered in the 'ready' position which can disturb concentration (worrying about maintaining position until the 'green' light comes on). All elite shooters try to manage the 'load' time period to avoid time spent standing waiting at the ready position.

It was difficult to see from the rear camera angle if Schumann, Reitz or Milev were balanced slightly forward. Schumann's head position, however, was slightly forward. Evglevski balanced slightly forward. They all lifted the pistol to the first target and traversed across the targets before returning to target one, with the exception of Schumann who swept the pistol slowly across to Target 5 and back. They did not sway during the lift or during firing.

All divided the 'load' period into segments, an example being Schumann who managed the one-minute 'load' period in roughly 20 second segments: (1) load, (2) grip the pistol and settle the body position with hips parallel and stance balanced before turning to address the targets, (3) line up on Target 1, as shown by the video.

They all responded very quickly to the green light. Their pistol lift was smooth, straight up the centre of the first target, with the pistol levelling out on the centre of the target without bounce or wobble. (Bouncing sights destroy trigger control). Actions were smooth, precise, and consistent for each string with the pistol stopping before firing on each target, including in the four second series as shown by the slow motion sequences. The speed of the lift was similar for each time series, slightly faster in the 4-second series.

Christian Reitz appeared to slow the lift fractionally as the sights approached the centre of target. Video analysis occasionally detects an error such as a curving motion of the lift (failing to come up straight), or a quick downward movement oat the top of the lift (too high on the lift). These errors are costly in time lost, and disrupt concentration, even if only briefly. The actions of all the competitors observed suggests that they wanted to stay very focussed during the strings. This is especially true of Evglevski who can be seen in position, doing the empty hand traverse while waiting for the command to 'load'.

The methods used by the elite athletes studied and their first shot times are summarised in Tables 1 and 2 below, provide a guide to sound technique, and could form a useful diagnostic checklist for anyone whose scores have reached a 'plateau' and are looking to detect problems with technique by changing one element at a time to observe the result.

The qualification round of 60 shots is won or lost in the 4-second series. By using a similar lift speed in all series, thought slightly faster in the 4-second series, the competitors avoiding finding they were facing the crucial 4-second series but now having to do something different. The video shows that the final, phase of lining up on Target 1 was to increase the likelihood of being able to raise the pistol straight up the middle for the first shot.

Table 1. How elite competitors approached the lift

- They stayed focussed during intervals between the five shot strings and stood up straight, well balanced and immobile before the lift.
- After addressing the targets they can be seen dwelling on Target 1, taking careful aim and checking that their balance was centred for a straight lift. By the time "attention" was called they had finished preparations and the pistol was levelled on Target 1, ready to be lowered.
- They responded to the 'green' light very quickly and performed the lift of the pistol with a similar speed for each time stage, fractionally faster in the four second series.
- They did not sway during the lift or during firing which was smooth and precise with the pistol stopping on each target.
- They fired an imaginary sixth target on each series, then moved the pistol across the targets back to Target 1, then down.

Table 2 below, gives the first shot times for Schuman, Reitz Milev, through a half match in 2011 and Evglevski in 2022. The first shots were between 1.7 – 2.1 seconds in eight second series, 1.6 – 2.2 seconds in the six second series and 1.5 -1.6 in the four second series.

Table 2. First shot times

	Schumann		Milev		Reitz		Evglevski	
	Time	Score	Time	Score	Time	Score	Time	Score
8s	2.0	50	1.7	49	2.1	50	2.1	50
	2.2	50	2.1	48	2.5	49	2.1	50
6s	1.6	49	1.8	48	2.2	49	1.8	48
	1.7	49	2.0	47	1.8	49	1.7	49
4s	1.5	48	1.5	46	1.6	43	1.6	47
	#	44	#	48	#	48	1.5	46

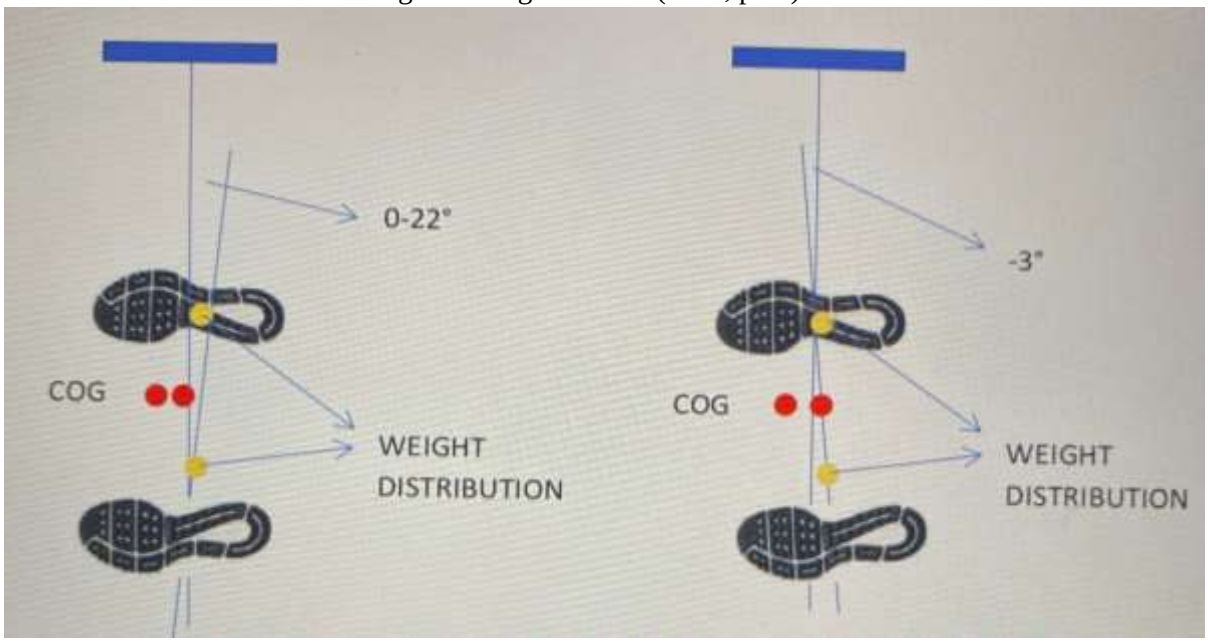
Note: First shot times were taken from the moment the 'green' light came on. # Indicates a slow motion sequence with the first shot time not able to be recorded. Schuman's final 4-second series, included a "5" on the last target because he slowed to correct an error and by the fifth target found he was running out of time so fired a hurried shot. The first shot times were recorded by the author watching the green light come on and marking that to video by flicking the fingers past the lens. [*Technical note:* Video data from the camera sensor cannot be read by the human eye, necessitating software conversion. It is possible that this conversion process could skip frames, so the times given for the first shot could be 1.5 seconds plus 0.2 seconds. The video files used for the first shot time analysis were converted direct from the digital camera output].

Schumann can be seen using an arm exercise for the back muscles and rolling his shoulders while waiting to continue the match. For some unknown reason, Reitz consulted a stopwatch before the eight second series, possibly to check the timing of his traverse across the targets. At the conclusion of the string he sometimes did two, fast upward lifts and was seen once shaking his non-shooting arm before a string. It is thought that exercising the non shooting arm can change the muscle tone of the shooting arm helping recovery in situations where it has been doing most of the work (Evglevshki, 2022). Another relaxation technique, thought to calm the 'jitters', is to squeeze a ball with the left

hand before action with the right hand. Katwala (2016) suggests that this has a calming neuromuscular benefit, which, in the context of pistol shooting could help to avoid snatching at the trigger. It is said Schumann used a squeeze ball in his left pocket, later in his career.

According to the ISSF the side on stance has the advantage that the recoil is not absorbed by the wrist or arm avoiding these deflecting. Instead, the recoil travels straight from the entire arm to the torso (Coaching Manual Pistol, p49). The feet should be wider than the shoulders as this gives greater stability and the legs straight and without tension as this is necessary for efficient rotation from Target 1 to 5 (ISSF). Physical conditioning is important for precise movements during the lift and traverse and benefit from good core stability from conditioning the abdominal, lumbar, and dorsal muscle groups (Schumann, 2017).

The left arm can aid rotation if positioned slightly to the rear and held close to the body (ISSF, p.47). Holding the body erect is preferred (ISSF, p.43). The head is kept immobile after the sights have been set on the reference target (Target 1 or 3). Some elite shooters do not look down to check that the arm is at 45 degrees for the ready position, so as not to risk disturbing the head position. For Rapid Fire Pistol, the centre of gravity (COG) - the line passing through the centre of the body mass to the feet – is shifted more towards the right foot (right handed shooter) as well as being positioned slightly toward the toes as shown in the rightmost figure below (ISSF, p.43).



Shifting the centre of gravity slightly forward is seen in the video of the Commonwealth Gold Medalist, David Chapman who called it “adding a slight forward lean but not so much as you have to dig in your toes” (Anderson, 2011). The ISSF Coaching Manual notes that the double dot between the feet in the above diagram indicates there is a choice whether to include a forward lean or not (p.43).,due to individual differences in physique. The position of the feet in the leftmost diagram, shows the front foot withdrawn slightly behind the rear foot on a line to the middle target, by 22 degrees. The rightmost diagram shows that on a line to the middle target, the right foot is placed slightly forward of the rear foot, the angle being -3 degrees (ISSF, p.43). The ISSF prefers the right foot has to be turned slightly toward the target (p.13).

Rotation method

To accelerate the movement of the pistol between the five targets, stopping on each one, necessitates turning the body as a unit with the movement coming from the knees and lower leg muscles with the ankles flexible. The important outcome is that at the moment of firing, the stance is the same for each target, due to the rotation of the entire body. The situation where the body is rotating slightly behind the line of the arm to the target, is to be avoided as this causes the sights to go out of position, necessitating corrective movement.

Since the shooter's intention is to traverse across five targets and since the turn occurs by leverage of the feet against floor, it can help new shooters to learn the important skill of starting the body rotating as soon as the first shot is fired by advising them to 'turn from the ankles'. As the turn from the ankles reaches the limit of 5 degrees of turn (about the middle target) and since the intention is to traverse across the five targets, the knees, already having begun to move, take over. It should be stressed, however, that the greatest precision for the turn is obtained by rotating the body from Target 1, as a unit, with knees and angles turning as one, dispensing with the advice turn from the ankles'

Ralf Schuman addressed the role of the ankles noting that they are free to move along with the knees but that the feet should be locked. He locks the hand, wrist, elbow, backbone and hips (2017, 29). His view about having the hips locked is taken to mean that they are locked in the sense that they become a unit which is rotated around the centre of mass of the body as it accelerates to the next target before stopping to fire, accelerates again, and so on.

The ISSF prefers that the shooting arm is totally stretched out allowing the elbow to be locked with the arm tension greater than during precision shooting. This, the ISSF suggests, will transfer the energy from the recoil to the entire upper torso, as noted previously, and act to hold the arm in place for the rotation to the next target (p.48). Stretching out the shooting arm is not new. This was advocated seventy years ago by Pentii Linnosvuo, Finland, the only elite shooter to gain an Olympic Gold Medal in both Free Pistol and Rapid Fire Pistol. He believed that stretching out the arm brought the ligaments into play, improving aiming stability. The ISSF recommends that the right shoulder be fixated by lifting and pulling it forward (and stretching out the arm). This is particularly noticeable in the video of Sanderson. An exception for some veteran shooters, whose tendons and muscles have thinned due to ageing, is to compensate for wear in the bones, muscles and tendons of the shoulder by drawing the arm back into the shoulder to improve stability.

2: Trigger set-up

The event requires taking up the trigger pressure as the pistol is moved toward the centre of each target and stopping to release the shot. In the four second series, the shots must be fired in around 0.6 seconds each. The pistol should a responsive trigger capable of fast firing and be capable of fast cycling and fast recoil recovery have.

One option for the trigger set-up is to have the shortest possible trigger pull with almost no movement before the hammer falls and with the trigger stop set to stop rearward travel after the hammer falls. This potentially gives a fraction more time to fire during the fleeting moment that the sights are over the ten-ring, especially in the four second series. A potential disadvantage is that there is very little 'feel' as the shot is released.

The option favoured by most elite shooters is to have a trigger which allows you to feel the trigger pressure being taken up during the acceleration phase of the pistol, up and across. This helps in timing the shot release. Importantly it allows the brain to more easily form a feedback link between a good

shot (a ‘10’) and the pattern of signals received from thousands of proprioceptors in the fingers (as touch sensors), and in muscles, bones and tendons. Proprioceptors give us a sense of where we are in space and a feed-back loop can be formed between our awareness that a shot was good, a ‘10’, and the pattern of proprioceptor signals for producing that shot, read and able to be memorised by the brain. Repeated matching of a “10’ to the pattern of signals associated with its production, is how skills become more precise and automatic and is the foundation for high performance in rapid fire. The recognition by the brain of the signals received from proprioception is sometimes wrongly called ‘muscle memory’ but it is ‘proprioceptor pattern memory’.

Below, are choices for the trigger set-up, bearing in mind advice of the Commonwealth Games Gold Medalist Pat Murray that:

You’ve got to know when it’s going to go’,

1. A straight through roll-off trigger such as used by Sergei Evglevski.

2. A two-stage set-up trigger with the first stage requiring about 640 grams of pressure and the second stage 400 grams to release the hammer, believed to have been used by Ralf Schumann. Having the first stage heavier than the second stage means that the first target is fired with, in effect, a 400 gram trigger. The heavier weight of the first stage means that during the stroking movement of firing the remaining shots there is only a slightly perceptible first to second stage feel.

3. A variation of the heavy first stage trigger, used by the Commonwealth Gold Medalist, David Chapman, is to have the first stage at 800 grams with short movement and the second stage a crisp 240 grams. This trigger has the advantage of reducing to a minimum, the time needed to release the shot. After the first shot it also has no recognisable stages, just a smooth activation but this configuration can difficult to learn, and may be difficult for new shooters.

4. A two stage trigger with the first and second stages equal at 500 grams. This type of trigger is used by the former Australian Champion Bruce Quick and allows the second stage to be felt as the shot is fired.

5. Other variations of a two-stage configuration include the first stage being set lighter than the second stage. It has been noted the new shooters can benefit from a slightly longer trigger pull as this can help them avoid ‘snatching’.

The technique you use for shooting the match also influences trigger set-up. For example, taking the case of a heavy first stage, say 640g with 1mm or 0.5mm of pre travel and a sharp, crisp second stage (or a short roll-off of 0.5mm before the hammer falls), the technique would be to take up the first stage during the acceleration up to the first target and between targets and release the shot as the sights stop on the target centre. The set-up chosen should be able to be used in the tension of competition not just in the calm of practice. Stopping is essential but becomes more difficult as the time sequences shorten. Slowing the pistol and sliding it through the ten-ring during firing rarely produces accurate shots. Stopping on each target improves the ability to time the shot release and is one of the skills which need to be made automatic through extensive practice.

Another important factor is how you grip the pistol. The fingers wrapped around the pistol stock should pull the pistol straight back into the hand, in sympathy with the direction of the trigger finger during fast firing being straight to the rear at the instant the hammer falls. Important too is how how skilled one is in timing the shot release to occur when the sights are over the ten-ring. A final

consideration relates to error correction when things go awry. When the brain detects and error which it can do in 50 milliseconds, working memory is opened – something akin to a scratch pad on which to record temporary notes – to calculate the necessary muscle movements to correct the error. In elite shooters we could expect this, in many cases, to be more like retrieval of a known solution, rather than a new calculation. Error correction benefits from a fast trigger, to recover some of the time lost making the correction.

Electronic triggers, not now used in elite rapid fire competition, offer the advantage that the trigger finger could stay in contact with the trigger. The disconnector function which in mechanical triggers requires the trigger finger to be moved off the trigger to allow the hammer/sear relationship to be reset being taken care of in the electronic circuitry. Perhaps a reliable electronic trigger will be developed which can handle the fast firing (fast capacitor recharging) of the rapid fire event.

A desired outcome of setting-up a rapid fire trigger is that you know when the pistol is going to fire. This helps getting the timing right for the shot to go during the fleeting moment that the sights are well positioned. Smoothness of trigger operation is essential, as is avoiding "picking" the shot as this can destroy accuracy. Trigger travel of 2mm or less is favoured with the final release set to be smooth as if the trigger is falling away ('rolling-off not binding). The trigger should allow you to 'feel' when it will fire and this requires hours of practice, including dry-firing, to become automatic. This type of trigger, when you get it right, has been described as a trigger which 'talks to you'.

Grip

Grip pressure should be as firm as possible without causing the sights to vibrate from the strength of the grip. Sanderson (2008 Olympian) advises: keep an intense consistent grip. The ISSF state that a strong grip prevents "displacement of the gun during repetitive shots" (but not so strong that it induces wobble, Anderson, 2011). As mentioned, the grip should fit into the hand so that the fingers pull the grip straight back into the hand, so as to be in sympathy with the stroking action of the trigger finger during firing with the trigger moving straight to the rear at the moment the hammer is released. The ISSF advises that the pistol should be placed deeper in the hand for "better recoil absorption" (ISSF, p.49). This is not new. When Virgil Atanasiou, Romania, broke the Rapid Fire Pistol World Record in Wiesbaden, in 1966 with a score of 596, he placed the pistol in the hand by gripping by the barrel and driving it firmly into the space between the thumb and forefinger. It should be noted that most pistol stocks (grips) designed for the rapid fire event assume that the shooter will stand side on to the target.

Developing a fast lift

Matches in the ISSF Rapid Fire event are won or lost in the 4-second series. Elite ISSF rapid fire competitors release the first shot in this series in 1.5 seconds (Table 2). The logic for this is that the remaining shots have 0.6 seconds available for each shot. The timing is: [1.5s + 4x 0.6s (= 2.4s) = 3.9s total firing time]. This leaves around 0.2s for the shot to penetrate the target (within the 4.20 time limit). This timing gives greater likelihood of achieving a high scoring shot consistently on the remaining four targets, compared with trying to get a high scoring shot in less than 0.6s. So, training for a 1.5s first shot is sound strategy. Not wasting thime during the lift is therefore important.

Discussed here are two of the ways to start the lift for the 4-second series: a "whip start" or a soft start, accelerating lift as you drive up to the target centre. The "whip start" gets the pistol very quickly up from the ready position to where the sights come into view but it can place stress on the shoulder. It could be better suited to those whose physique can balance the upward force of the lift.

The important outcome is not the just the speed of the lift but that the pistol arrives smoothly at the top of the lift, stops on the centre of Target 1, and that you apply consistent trigger pressure, timing the shot to go a fraction of a second after the sights steady at the top of the lift. The other variation, the soft start, accelerating lift, puts less loading on the shoulder and is preferred by some elite competitors. Both make use of reference points and "breaking the "beam" of your eyeline vision to the reference point you have selected at Target 1.

For both variations, imagine you are behind the sights and:

- Line up on the target, balanced with a slight forward lean (optional, but advised depending on physique);
- Begin with light trigger pressure. If using a two-stage trigger (e.g. 640 grams first stage 400 grams second stage) bring the trigger pressure to the first stage;
- For the "whip start" watch the reference point on the target which you have selected from trial and error as the point where you turn off the lift to allow momentum to bring the sights to the target centre, as you simultaneously increase trigger pressure to release the shot. The reference point becomes your line of vision to Target 1, acting as a kind of beam from your eye line to the target. It also places your vision at the target, helping you detect the start signal early. When the foresight "breaks the beam" at the reference point, shut off the lift and apply the final pressure to release the shot in the fleeting moment after the sights stop in the middle of the target. "Breaking the beam" pulls your vision onto the front sight and its alignment with the front sight (important as accurate shooting cannot be done without the rear sight in focus). The position of the reference point depends on how fast you drive the pistol upward. Some competitors look down to pick up the sights but that is not necessary if using the "break the beam" technique;
- To sum up, when the signal to begin the series is given, drive the pistol upward, a sort of whip action but with the pistol controlled like on a hydraulic ram. Pull focus from the reference point, to the sight alignment, being especially careful to see the front sight (so sharp you could cut your finger on it) and its alignment with the rear sight. Adjust the sights as they arrive in the centre of the target. Very little adjustment will be needed if you brought the pistol straight up the centre of the target. This leaves you to bring the pistol to a stop over the target centre while completing the trigger release which was started at your reference point;
- The soft start, accelerating lift variation, requires you to concentrate on the acceleration phase of the lift as you drive the pistol upward toward the centre of the target and then to concentrate on tapering off to stop on the centre of Target 1 while increasing the trigger pressure to time the shot to be released a fraction after the sights are level;
- For both variations, while addressing the targets, visualise the sights arriving in the 10-ring and recoiling for a perfect shot release. Visualisation gives your brain a rehearsal of what you are about to ask it to do. It gives your brain the goal you want it to achieve;
- In the ready position, before the signal to start, build mental readiness to move quickly. "Self-talk" pertinent instructions to self about what works successfully for you, can be important at this point. The late Alex Taransky, Australian Champion and Olympian, would say to himself "Come up straight". My "Self-talk" was "Make like a tiger" meaning get ready to spring (into action). Building your anticipation to a high point has the benefit of focusing your mental resources on the present task. It can shorten reaction time and increase accuracy by heightening your concentration.

Follow-through

Elite shooters include follow-through as a normal and automatic part of the shot process. Effective follow-through means flowing through on sound technique. The groundwork for this begins, therefore, with establishing the stance and the interplay of tensions throughout the body which you have found give best control over all the actions involved in accurate fast shooting. Follow-through is important because there is a very brief time gap between the brain deciding to release the shot and the arrival, at the trigger finger, of the brain signals sent from the spinal cord out along the arm to the trigger finger to fire the shot and, for the projectile to clear the barrel.

Without follow-through, during this very short time interval, change can occur to the continuity of aiming and consistency of trigger pressure as muscles involved in the ‘’interplay of tensions’ relax in unknown ways because the brain regards the shot as having been fired. A potential “10” can become a “5” or worse in the last tenths of a second of the shot release. This error in the last moments of the shot can be unseen if the brain has turned off concentration on the shot and attention has gone elsewhere, hence the importance of “calling the shots”.

In the ISSF rapid fire event, follow-through becomes automatic when concentration is intently applied to sound technique as you drive to the centre of each target, maintaining grip pressure and drawing the trigger into the trigger stop, seeing the sights rise and fall in recoil until the sequence has been completed. As the video sequences show, elite competitors keep the traverse level, stop on each target and fire an imaginary sixth target. The firing of a sixth target keeps attention on the shot process (grip pressure, sights and timing the shot release to occur after the sights stop level and on centre). The arrival back at the first target of the reverse traverse, marks the end of the concentration span for that series.

The diagnostic tests for whether there is failure to follow-through include: whether the size of the group, has widened (because you have lost concentration on the sights or have stopped applying consistent trigger pressure or the pattern of tension supporting your stance has started to crumble), whether there was increased wobble anywhere in the series during shot release, whether the position of the group was centred and, in the case of a poor shot: Did you see it happen at the sights? Being unable to call the shots, because your concentration faded in the final moments of the shot, is a symptom of failure to follow-through. Sanderson (2008 Olympian) describes follow-through as ‘nothing changes after the shot …. Work to align your sights, keep an intense consistent grip and hold your pistol in the aiming area’

3: Developing concentration

At any top level competition, those who qualify can hit the ten ring most of the time. They have developed skills for fast accurate shooting, making them automatic. In other words, the conscious control of movement - needing to think about the actions to be made – is replaced by automatic processing of the neuro-muscular skills need to perform the actions. This is much faster than conscious control of movement.

Individuals can lift to high achievement levels when automatic skills are coupled with high concentration. High concentration, in turn, can induce a mental state called ‘flow’ or ‘being in the zone’ and this can bring about a number of changes. The most important change is that neuro-transmitters are released in the brain which can induce heightened and energised focus and improve awareness, including visual awareness and other beneficial changes which have been associated with high athletic achievement.

Being in a flow state or in the zone is believed to enhance performance in situations where:

- skill levels are high (skills are automatic, meaning you can do the task without thinking);
- the challenge you are facing is high, and
- you have a strong drive to excel (you dig deep for something extra).

These conditions may bring about changes in brain functions for the current task and then disappear. According to the theory, you cannot just enter flow, it arrives, and the experience is effortless effort. The flow concept is an attempt to explain how, in situations of high challenge when you are calling for extra effort, complex electro-chemical brain wave processes could be brought into play to free additional brain resources. However, "flow" is not essential for high performance.

At present, flow is a promising way to explain what could be happening during exceptional performance but research has not yet unravelled how it works. "Flow appears to be a whole-of-brain phenomenon. Does "flow" cause improved performance, or does having a good day, being on "flow" or does performance and "flow" act to build up each; a reciprocal relationship. Neuroscience research proposes that brain retains a copy the last outgoing signals sent to the muscles, called the "motor efferent copy" ("motor" referring to movement) (Whitford, 2017). When the first shot fired is good (no error correction needed), and all going well, the brain only has to keep repeating the last action to "flow" through the series. If "flow" changes normal patterns in the brain, as noted above, due to release of neurotransmitters, this could possibly result in more brain resources being assigned to the present task for its duration, presumable increasing performance.

The theory proposes that the "flow state" is easily lost, if one thinks about how well things are going. A high level of skill backed by total immersion in the task is essential for high performance. Can you train for "flow"? If you were to try, then train to make skills automatic, set the training goals to challenge the top level of your current ability and, this could be the most important part to practice, drive your concentration to the highest level. A short description of "Flow" theory follows.

According to the literature on the phenomenon of 'flow' there are two preconditions for entering the 'flow' state: first, there should be a challenge with clear, achievable goals and second, the necessary skills must be automatic. (Katwala, 20216), Also, one cannot step in to the flow zone at will (See 'Searching for the flow zone, Anderson 2018).

The right side box in Table 3 below, outlines what can happen, according to the literature, when the mental state of 'flow' is present. The shot process begins with visualisation of the look and feel of a perfect string of shots, prompted by 'self talk'; pertinent instructions to self about what is critical for success in a particular task. Prior to making the shot or shot sequence, self talk is terminated (get your head out of it) so as to bring your mind to a state which is open and intensely aware, as you go into the process of making the shots. In the process the conscious level of the mind becomes relegated to a monitoring or watching role, ready to act it something goes wrong and that the performance of the skills is automatic and therefore faster.

Flow' process …… high concentration continues through shot delivery

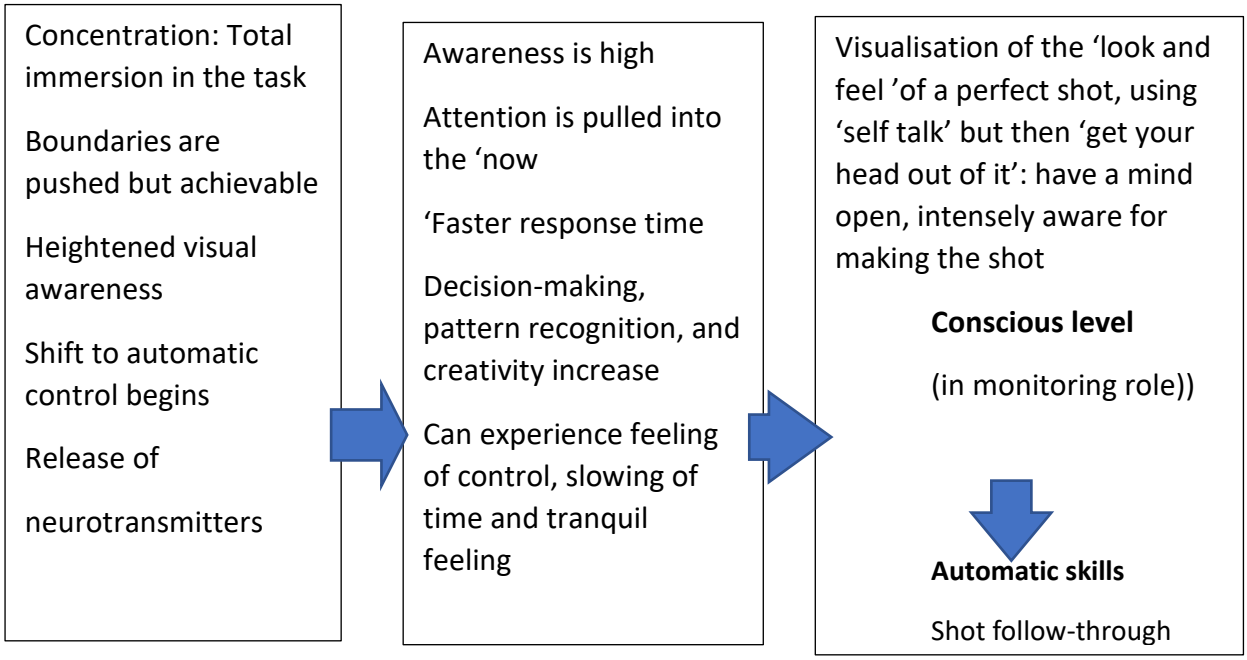


Table 3: Flow process during high concentration

Top shooters can switch between conscious and automatic modes to correct an error (Bertollo, and others, 2016). Those who have experienced the 'flow' state report a loss of the sense of self, for example, firing a rapid fire string during high concentration can seem like watching a movie of perfect actions, even you are aware you are firing, the actions just seem smooth. If you have an interest in reading "Searching for the flow zone" go to targettalk.org, Shooters Lounge, page 18 or nearby and click "here" on the posting by Spencer as Figures 1 and 2 have essential

It is important to avoid overthinking the shot as this involves a different part of the brain, the pre-frontal cortex, which can result in movement slow and less fluent (Katwala, 2016). Even though you have the necessary skills, overthinking the shot can make you clumsy.

Methods for dealing with distraction include having a particular routine when preparing to shoot which can provide a kind of mental cocoon in which to wrap yourself as you load and prepare for the shot or series. The video of Evglevski shows that his practice routine is almost identical to his preparations on the firing line. 'Exclusion' is also used to consciously remove distractions before the match. 'Self-talk' can be used to substitute positive thoughts for negative one and, according to Cotterill (2018) improves the execution of movement. An example off substituting positive thoughts for negative ones is to think good shooting, e.g., visualise the sights perfectly centred and feel a smooth, consistent trigger action as the shot is released.

Visualisation is a particularly powerful mental tool. It engages the necessary neural networks in the brain and sets the muscles into anticipatory mode to achieve the visualised outcome and can both shorten reaction time and improve the timing of trigger action, especially in fast shooting. It is also

effective when used to block out a distraction, for example, by visualising the sights perfectly positioned in the aiming area and the pistol recoiling for a perfect shot. Having clear goals is also important. According to (Cotterill, 2018) goals should be specific, measurable, action-related, realistic and timetabled.

4. Training plan

The following plan is based on the research described above.

First, think about the essential nature of the match as requiring fast aiming, fast rigger action, necessitating a responsive, fast cycling pistol with a grip, so well fitting, that it does some of the aiming for you. Check Table 1, which summarises the key competencies demonstrated by the observed competitors, and the timings for their first shots in the various time sequences (Table 2). Keep in mind that key skills including follow-through must be practiced often enough to make them automatic.

1. Work out what you need to do to fit yourself to the requirement of the match. Encapsulate this in a checklist, written or held in the mind, to go through to focus concentration on what counts when setting up for the shot or series.
2. Find your best balance when taking up the position to pick up the pistol and again, when lining up on the on the centre of the first target at the end of the 'load' time period. Learn to conclude this period at one minute with aiming finished and the pistol ready to be lowered.
3. Give emphasis to the first shot: timing trigger release with a smooth, straight up the middle lift to the centre of Target 1. Practice to release the first shot around 2 seconds for the eight second series, 1.8 seconds for the six second series and 1.5 seconds for the four second series.
4. When practising part of a sequence of actions, such as the lift to Target 1 for the first shot then to Target 2 for the second shot, include practice of the full five target sequence as this can speed learning (Ledermann, 2010).
5. Train to make key actions automatic, selectively in the beginning, e.g. linking trigger action to aiming to follow-through, in a smooth flowing process.
6. It is very important to avoid overthinking the shot so get your conscious brain out of it as you move into the shot delivery sequence, for example, by stopping 'self talk'and by merging the mental process of setting up for the shot into a, highly aware mental state where the mind is open and ready to act.
7. Train against a challenge either real, as in competition, or manufactured during practice and include 'non-typical' events to develop and practice coping strategies. Correct technical errors during the match (and during practice), as they emerge, revealed by comparing the impact point of the shot with where you thought the shot landed (calling the shots).

References

Bertollo et al. (2016) *Proficient brain for optimal performance, the MAP model perspective.* Peerj 4:e 2082; DOI 107717/peerj.2082. Cotterill. S., (2018). *The psychology of performance.* Routledge. Oxon.; Chapman, D (2022) Personal communication. Mamo, C. Personal communication; Evglevski, S., 2022, Personal communication; Katwala, (2016) A. *The athletic brain. How neuroscience is revolutionising sport and can help you.* Simon and Schuster. London; Lederman, E. (2010); *Neuromuscular Rehabilitation in Manual and Physical Therapies*, Elsivier. Edinburgh. ISSF.org. Pistol Coach – Level 1. (2020). *Pistol shooting theoretical_material.* Pdf. (ISSF National Coach

Course. *Pistol shooting position.* By Zelico Todorovic; Sanderson, K., (2010) Pistol lifts. Schumann, R. (2017). *Rapid Fie Pistol. The author,* Whitford, T., J., and others, (article relating to efferent copies) https://doi.org/10.7554/eLife.28197

By the author: Anderson, T.

'Searching for the flow zone', targettalk.org, (see Figures 1 and 2);

The ISSF Rapid Fire event: Training and techniques. DVD Video; Competing, Sightline, 2018 (St Ives Club Bulletin);

Rapid fire shooting in the 1960's, *Australian Pistol Shooters Bulletin,* 2020

Dissecting a precision shot, *Sightline*, 2013.

Using clear mental pictures, *Sightline*, 2009

Training aids, The SCATT system, *Sightline* 2014

Follow-through, a neuromuscular perspective, Sightline.

Trigger control, targettalk.org, Olympic Pistol Forum

Some exotic development of the Margolin Pistol, with Bob Gee, targettalk.org

Appendix A

SEMINAR: Advanced ISSF Rapid Fire

Notes for presenter as to what is on the video

(1) 4-sec series

Shooting advanced level ISSF rapid fire requires getting to grips with the 4-second series. This sequence shows how fast is the 4-second series. It was recorded during an Australia Cup match at the Sydney International Shooting Centre. The first shot is fired in just under 1.5 seconds and the remaining shots between 0.5 and 0.6 seconds each. On a high resolution monitor the first shot can be seen speeding into the top of the ten ring. The competitor is the author.

(2) Warm-up

Note the leisurely pace. The shooter in red is the Brazilian Champion, Jorge Llamas. Also seen is Vijay later an Olympic medalist and Ralf Schumann at the end in the blue tracksuit.

(3) Sergei Evgleski warm-up (NSW State Championships 2022)

Sergei's warm up is unhurried. He is careful to establish balance and to rotate his body to address the first target without changing (twisting) his hip position. His lift is straight up the middle of the target to level on the target centre. He looks at the ten-ring when doing the lift. Doubtless he picks up the sights in his peripheral vision as the they approach the ten ring. The speed of his lift is 1.5 seconds before levelling out. The rear view shows him exercising his left arm by lifting a drink bottle. This, as mentioned elsewhere, is believed to help relax the right arm when it is doing most of the work. His feet are positioned in line with the targets but the rear foot is about 30 mm behind the front foot.

(4) Sergei qualification round

Again, Sergei is very careful to set his balance. At the command 'load' he uses the empty hand traverse across the five targets, firing an imaginary shot at each one, then sweeps the pistol back to Target 1, then loads the magazine. This method of preparing for the shot conserves energy. Other competitors usually load the magazine before addressing the targets. His timing of the preparatory routine means that at the call 'Attention' he has finished aiming at Target 1 and is ready to lower the pistol. His posture has a slight forward lean.

(5) Sergei final

Shows Evgleski with Scott Anderson to his right, during the finals of the NSW State Championships. A "hit' is a score of 9.7 or higher and is shown as a white circle.

(6) Ralf Schumann, Emil Milev, Keith Sanderson, Christian Reitz

Schuman is seen toward the end of his career. He retired about 18 months after this match which was recorded at the Sydney International Shooting Centre, 2011. Note his shoulder exercises. The final 4-second series was recorded in slow motion and shows that on Target 4

he arrived low, under the ten ring, corrected upward to fire a ‘10’ but then, found himself running out of time so fired very quickly at Target 5, scoring a ‘5’. He still finished second on the qualification round. Emil Milev is seen rocking back very slightly as he fires and seemed to be having a bad day. Sanderson uses a high thumb position which can help trigger action for some shooters. He said his posture was designed to reduce recoil.

(7) Christian Reitz

Christian is seen at the beginning of his career. He later became a record holder in the Rapid Fire Finals for the number of ‘hits’ and achieved World No 1 Rank. Here he is using an electronic Pardini which is not now used in World class competition due to problems with malfunctions and Pardini have abandoned its manufacture. However, the electronic trigger had one unique feature; the trigger finger did not need to be taken off the trigger when a shot was fired as the disconnector function was handled by the electronics. At this stage of his career Reitz was using the technique of slowing the upward lift fractionally as he arrived in the ten ring, Doing rapid lifts after completing a string is something he often did later in his career and may have been, in part, an expression of annoyance at something not quite right. The slow motion video of his 4 second series shows he was stopping on each target.

(8) David Chapman.

David is seen setting his balance. At the conclusion of this process he can be seen adding a slight forward lean.

(8) Trigger

The athlete is Travers Coward (VIC) who has represented Australia in World Cup competition. He said he is squeezing the trigger during the 8 and 6 second series but cannot say if he is squeezing the trigger in the 4 second series. Note: The Pardini Rapid Fire pistol, seen here, requires the trigger finger to move off the trigger sufficiently that the disconnector, which stops multiple shots, can be disabled briefly before reengaging the sear allowing the next shot to be fired. The shooter may have been distracted by the nearness of the camera but it does look like he is tending to slide across the targets rather than stopping on each one.

Appendix B Seminar agenda: Advanced ISSF Rapid Fire Pistol.

1. **Welcome, introduction, plan of the day.** Distribute handout: Research-results-discussion. The handout is intended to allow more time for questions or comment).

2. **Seminar Aims and objective.** The seminar will draw on video analysis of elite athletes, noting the commonalities in how they approach the event with the aim of improving participants' knowledge and skills in how the ISSF Rapid Fire event is shot by experts. Enhancing participants knowledge of the techniques of master practitioners will, in turn, enable sharper self-review of shooting outcomes, and help participants develop training plans to improve match performance. Participants will have live fire practice to review and evaluate adjustments to technique. At the completion of the seminar participants will have a greater understanding of the process for lifting their performance in the ISSF rapid fire event and have a Training Plan for developing the skills identified by the video analysis. (Handout: Section 4).

3. **Summary of key competencies for high performance in Rapid Fire Pistol**. Refer to Handout Tables 1, and 2.

4. 4. **Video analysis of elite ISSF Rapid Fire athletes.** Presenter starts the video and explains who is being seen and what to look for. The video covers a 4-second series, warm-up processes and half match performance of Ralf Schumann, and Emil Milev, and a full match performance by Christian Reitz, and Sergei Ecvlgeski, with timings for first shot, and scores achieved. The video includes Keith Sanderson (USA). Schumann, Reitz, Ecvleski and Sanderson will be seen shooting the 4-second series in slow motion. Subtle differences in style are identified. Common elements in how the match is handled are in (Handout: Tables 1 and 2). Also included is video of how David Chapman sets his stance and slight forward lean and a close-up of trigger action in 8,6 and 4 seconds (Travers Coward, Qld).

5. Trigger set-up. Discusses ways of setting the trigger and the value of having a trigger with 'feel'.

6. **The mental side of shooting.** Refer to handout. Discussion topics can include the importance of making skills automatic; what to do when your scores 'plateau' (starting point is Tables 1 and 2); role of self-evaluation when deciding what to work on next; building concentration and the use of agenda setting and 'self-talk' to integrate skills and concentration during competition.

7. **Participants design and discuss technique changes to try out in live firing.**

8. **Live firing with on range discussion as needed.**

9. **Conclusion.** Synthesis of what was learned Option of offering a review of any after thought'. Questions or observation of participants (by email).