Part II: The Physiology of Performance in the Tactical World

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INTRODUCTION

As a general rule, the body follows the instructions of the brain. This assumes, of course, that your body is physically fit, nutritionally sound, adequately rested, and adequately rehearsed (the result of repetitive training "repetitive task transfer" – what used to be called, erroneously, "muscle memory"). We've all seen older operators and athletes outperform their fitter or younger colleagues in certain circumstances. This can only be accounted for by a difference between their brains, not their brawn. The question of what, exactly, is going on in a more experienced or better "conditioned" brain is the subject of this lecture.

The preparation of the body to follow the brain's instructions has been covered in other lectures on nutrition, exercise, and physical fitness. Here, we'll look at some of the tried-and-true "mental/physical training" techniques that have been used successfully in real world tactical environments by some of our Tier-One operators. These are very simple, practical, concrete training methods that have proven themselves in the worst circumstances. But we won't stop there. Modern physiology and neural imaging techniques are finally beginning to catch up to the study of athletic and tactical performance, and those scientific tools may shed light on what the brain is doing under stress. Physiology and neuroimaging findings may also suggest ways what we can help train the brain and perform more efficiently. The operative goal here is simply to give the good guys an additional training advantage over the bad guys.

We'll focus on two topics: 1) selective attention; and 2) "physiology as a weapon". Before that, however, I'll highlight three very simple teaching and training techniques that take advantage of the known science, but that don't depend on any detailed understanding of physiology or mechanisms.

The first technique is called "triangular instruction". The method is straight-forward: three participants are included (A, B, and C). A teaches B something while C is observing the interaction, then B teaches C while A observes, then C teaches A while B observes. The subject matter being taught could be mental, verbal, and/or physical – it doesn't matter. For example, it could be teaching a recipe for barbecue sauce, or it could be demonstrating knife strike zones.

To some extent, triangular instruction takes advantage of peer pressure because while B is being instructed, he knows that he is just about to be asked to instruct C the same material. It would be pretty embarrassing to have forgotten the material in the few seconds between being taught by A and being asked to teach C. The immediate repetition between observing, learning, and teaching reinforces the lesson and consolidates it in memory. Better yet, all of this is reinforced by peer pressure and the peculiar, intense, and active attention that peer pressure affords.

An example of lessons learned from triangular instruction being put to use against pirates off of the Horn of Africa will be given during lecture.

The second technique is called “scaffolding”. The analogy comes from arches – either natural arches, like those that form in the desert, or man-made arches like those in Roman aqueducts and bridges. At first glance, an arch seems like a tricky structure to build – sort of a catch-22. Each stone or part of the arch supports the rest of the structure, and it’s all held in place by a capstone. How did each of these pieces get in place and stay in place before the whole arch was assembled and self-supporting? The answer is that the arch had scaffolding, or external support, while it was being built and the scaffolding was taken away after construction. Just because you can’t see it now doesn’t mean it wasn’t present and critical during construction. In the case of a natural arch, the “scaffolding” wasn’t wood or steel, but was an earth and stone mound that was slowly eroded from the inside, leaving a hole under the forming arch.

If you observe tactical training, a similar phenomenon occurs, and if we recognize it, we can take better advantage of it. When a novice learns a new skill, it helps if he recites verbal instructions to himself during practice. The voice can be his own or his instructors; it can be said out loud or to himself. It doesn’t matter. What does matter is that he has real-time verbal cues “talking” him through the task. As his training progresses and the repetitive task transfer hones his performance, he may abandon the “talk” and just do the task automatically, without a verbal accompaniment.

Another example of this is memorization. Depending on how you learn best, you may use a variety of mental crutches to memorize something important. As you continue to repeat what you’ve memorized – “burning” it into your brain’s circuitry – you eventually abandon the crutches and find it easier just to recite the memorized material without bothering to think about the crutch.

When interviewed, some of the more experienced tactical operators report that they use very few verbal crutches, or “mantras”, as they call them. On the other hand, novices tend to make greater use of them. In the last part of this lecture, which deals with the technique of “verbal override”, the idea of a special kind of verbal scaffolding will be examined as a potentially useful device for both experienced and inexperienced operators.

The third teaching technique refers to the roles of the “feeder” and “receiver” during combat, and it is also based on what we know about the “reactionary gap”. In essence, the reactionary gap is the time it takes to respond to a stimulus or a threat. Lay people call this simply “reflexes”. Studies that have measured this interval in professional athletes, like Formula 1 racers, find that there is a certain amount of apparently genetic variation. This is no surprise. Virtually every physiological or performance function is going to vary between individuals – even those who have the same degree of training and are of the same age and physical condition. As a general rule, however, the reactionary gap for simple responses is approximately 250 milliseconds. That is, if you hold onto a fixed blade holstered close to your midline (the fastest anatomic draw position), and strike a metal plate at heart level as soon as you hear a shot timer signal, you will probably never beat 250 ms (1/4 second) between signal and plate strike. Tier-one operators average about 400 ms, and someone who can consistently hit 300 ms is outstanding. It appears that we have a neurologically hardwired performance limit. Training, practice, and concentration can pare down our actual reactionary gap to approach the theoretical limit, but not beyond.

Are there outliers, or “reactionary gap speed freaks”? Sure. Just as there are shooting freaks. No matter how much you shoot and practice, you are unlikely to outperform what Annie Oakley did 100 years ago. The same is true of the reactionary gap. Michael Schumacher in his prime or Lewis Hamilton currently will probably beat you every time – both in a performance lab and behind the wheel of a Grand Prix racer. They are not only highly trained, but highly selected freaks of nature. But that doesn’t mean you can’t learn lessons from reactionary gap studies and use those lessons to your advantage.

There are several other demonstrations of the reactionary gap. Put a wad of paper on the floor. Hold your open palm a few inches above it. Your “opponent” will hold his open palm a few inches above yours. Without warning, he’ll initiate a grab all the way around your hand and snatch the paper right out from underneath your hand before you can respond to his movement. You have every advantage of distance and trajectory (a straight, rather than circular, path). Nonetheless, he’ll beat you almost every time, just as you’ll beat him almost every time when the roles are reversed. It’s the difference between action and reaction.

Another demonstration is to hold a dollar bill vertically from the top edge while your opponent holds his thumb and forefinger in an open “pinch” around the bill from below. Without warning, you release the bill. It is very difficult for the reactor to be able to pinch his fingers closed in time to catch the bill before it falls through his fingers.

Now put this concept together with the role of the “feeder” and “receiver” during combat. In essence, the feeder initiates action and the receiver responds to it. As you might guess, the feeder has an enormous advantage. That advantage goes beyond the obvious, however. Not only does the receiver have to add a reactionary gap into his response time, but the receiver also misses out on an opportunity to learn from every action/reaction sequence. In a sparring scenario, the feeder can initiate an action and watch how the receiver responds to it. Then, without warning, the feeder can initiate a completely different action or the same action out of sequence or at an unexpected time or coupled to a feint, or false signal, and learn from the receiver's responses. The receiver has no such opportunity to learn about his opponent.

If you consider combat from a physiological point of view, it is really a series of interlocking feedback loops between combatants – at any given snapshot in time, one is the feeder and the other is the receiver. One way to approach winning is for the receiver to turn the tables on the feeder – especially when the feeder least expects an offensive action. It is particularly important to consider whether or not a combatant is within your reactionary gap – or *visa versa*. In other words, can one combatant either initiate or react to a move within 500 ms without having to maneuver through more than one movement or action? If so, scripted CQB tactics, or any other tactic that requires conscious decision making rather than conditioned responses is simply not fast enough to protect you.

SELECTIVE ATTENTION

The easiest way for an operator to miss the boat is to focus on the wrong thing, or to fail to focus on the right thing. It doesn't take modern neuroscience techniques to reinforce this truism, but it's both interesting and instructive that the science of neuroimaging is finally catching up to the tactical world. It is now possible to correlate what we see happening with the kinds of selective attention tasks and mistakes that occur in force-on-force simulations or in the real world with specific kinds of brain activity.

Before looking at which parts of the brain are activated during which kinds of tasks, three general points should be made:

1. The conscious brain is only capable doing a small number of things really well at the same time.

2. The conscious brain is susceptible to external distractions that may push it off its game plan; and,

3. All of the above can be conditioned into tactically-relevant responses. By understanding how the brain works, and how the brain can fail us, we are in a better position to game the system to the good guys' advantage.

Let's start with a few things that the tactical world has already taken note of, and then add to it some new findings in neuroscience that fill out the picture, and that may allow us to harness attention networks in a better way.

First, the practical observations: Dr. William Lewinski of the Force Science Institute has performed studies dealing with selective attention. In a sense, he has rediscovered and reinforced what Nideffer and Sharpe noted back in 1978 when they wrote a book on attention control training. They pointed out that the brain's limited reserve of attention was divided into external and internal targets. In other words, you can concentrate on your own body and your own thoughts (internal attention), or on people and events in your environment (external attention). Even trained law enforcement operators in Lewinski's simulation studies were not capable of fully engaging both internal and external attention at the same time. Like many other aspects of conscious brain activity, it is a "zero sum game".

Next, we have the phenomenon of distraction. In his book "On Combat", Lt. Col. David Grossman gives many examples of military and law enforcement operators being susceptible to what he calls "the little puppy dog" – that is, an external mental distraction that tugs at your pants leg and pulls your attention away from something more important.

We now know where Grossman's puppy dog, and where Nideffer, Sharpe, and Lewinski's internal and external attention areas reside in the brain, and how they interact with each other. The recent advances in functional brain imaging (fMRI, in particular) have allowed physiologists to correlate behavior with very specific regions of brain activation. More importantly, the way these regions either reinforce or suppress each other provide some clues about how to harness and condition the process so that the operator can exert conscious control of it.

To date, the neuroimaging and neuroscience studies have been performed only in non-tactical environments. The world of neuroscience is largely unaware of the tactical world, and *visa versa*. Those of us who have some familiarity with the two areas would like to bridge that gap – eventually with neuroscience and neuroimaging experiments done on real tactical operators, and in tactically relevant simulations. Until that happens, we can at least borrow from the scientific findings and interpret them for the kinds of tasks that the tactical world cares about.

Now let's add the findings from neuroimaging. It turns out that the part of the brain responsible for selective attention resides in the right cerebral hemisphere, and is dispersed among three main areas. Because each of these three areas has several names, I'll list all three areas, along with their various designations, below:

1. The Dorsal Frontoparietal, Dorsal Attention Network, or "Internal Attentional Network" area. This is the area that is active during "top-down", or goal-driven conscious processes. In my animated slides, this region is simply labeled as 'Internal" and color-coded tan.

2. The Ventral Frontoparietal, rTPJ (right Temporoparietal Junction), or "External Attentional Network". This is the area that is activated by "bottom-up", or externally-driven stimulation, and that is susceptible to distraction. In the animated slides, this region is labeled "External" and color-coded blue. It is David Grossman's puppy dog.

3. The Locus Coeruleus. This is a small, paired nucleus on the brainstem that reacts to stress or pain, and that sends norepinephrine-containing neuronal fibers to other brain

areas, including the rTPJ ("External" network, above). It is abbreviated "L.C." in some slides, and is activated as part of the stress response that was covered in the first lecture.

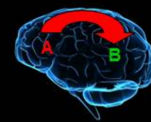
How do these three areas interact? The Internal (Dorsal) area is active when the subject is thinking, or planning – that is, when his thoughts are internally-directed. The Internal area is also responsible for directing the attention of other brain areas. For example, you are more likely to find the face of a friend (or a terrorist) in a crowd if you scan a crowd with a goal-directed mission of finding the friend (or a threat) than if you just cast a lazy eye over the faces without a pre-set goal.

Similarly, when you are driving a race car, there are too many external stimuli to track all at the same time, so your Internal network consciously directs your visual attention to the next curve, for example, then to the car on your inside for a fraction of a second, then back to the curve again. While this is happening, you consciously rob attention away from the tachometer, or the spectators in the stands.

Now suppose that something surprising happens: a bird flies up from the infield. Because you weren't expecting it, you have a startle response – almost a mini-stress response. Your heart picks up a few beats, your stomach knots. More importantly, your L.C. activates as part of the sympathetic stress response, and the L.C., in turn, activates your External network (also called the rTPJ in some of the figures from lecture) by releasing norepinephrine from the nerve fibers that innervate the External network. Now the External network activates, and, in turn, "reorients" the Internal network to command an attentional shift to the bird. In essence, the External network, like Grossman's puppy dog, has grabbed the pants leg of the Internal network and distracted the External network from the task of driving and instead reoriented it onto the task of watching the distracting bird. And all of this takes a fraction of a second. Nerves are very, very fast.

In the next section, we'll see what we might do, and what experts like Captain "Sully" already do, to tame the puppy dog and stay on task.

4 *Selective Attention (conclusions)*



1. Total working attention is fixed – it is a "zero sum game"
2. Attention is weighted toward the most important (or threatening) task at hand.
3. Attention can either be externally or internally oriented.
4. The location of some of the higher-level brain networks that handle attention have been identified.
5. Internal attention is located primarily in the dorsal (rear) right hemisphere.
6. External attention is located primarily in the ventral (front) right hemisphere.

4 *Selective Attention (conclusions)*

7. Planning, searching and goal-driven functions occur primarily in the internal network. During deliberate planning or searching, the internal network directs the external network's attention to the most important features of the environment – i.e., it forces the external network to stay on task.
8. Surprises in the external environment trigger activity in the external network at the same time that they trigger sympathetic activation.
9. Sympathetic activation, in turn, activates the locus coeruleus – a command and control center for our attentional shifts.
10. The locus ceruleus activates the external network at the expense of the internal network.
11. When activated, the external network re-sets the internal network to pay more attention to the new stimulus and forget the old plan (Lt. Col. David Grossman's "puppy dog" gets the operator's attention and forces him off task).

PHYSIOLOGY as a WEAPON

Understanding the sequence of events and the interactions between the three brain areas outlined above, an overall strategy can be formed to prevent distraction and stay on task. As a practical matter, and without knowing what the underlying physiology shows, Colonel Grossman has already taken a big step forward with his advice to use a "tactical breathing" exercise to overcome some of the side-effects of the stress response.

From the point of view of a physiologist, Grossman's breathing strategy works because it takes advantage of one of the few areas of overlap between conscious and autonomic control of our body. These areas of overlap include eye blinking and breathing. To some extent, we have some conscious control of our heart rate (for example, snipers and marksmen can be taught to slow their heart rates and entrain their shooting to it). For the most part, though, the easiest way to exert conscious control over the autonomic nervous system is to control the pattern and rate of breathing. By doing this, some other areas of the autonomic stress response are also brought to heel. It is also likely that the tactical breathing technique of Grossman works simply, and ironically, by distracting the combatant from the distraction of stress, and causing him to focus on something less fear-arousing than the fight.

A study of the neural networks involved in tactical-like task performance, as well as a study of what people do to rescue themselves from a stress response combine to suggest another strategy that may be effective in the tactical environment. I'll call this "verbal override".

Two non-tactical illustrations may help to clarify what I mean by this:

In 2002, the comedian Jay Leno was invited to be the first North American to drive the Mercedes-McLaren SLR supercar at a test track at the Idiada Proving Grounds in Spain. The car was still in development, was hugely expensive, and it was surrounded by a small army of very serious Mercedes engineers. Needless to say, the pressure was on Leno to perform, but also to bring the car back safely from his >200 mph test run. At one point, he pushed the envelope too far and the car spun out of control. The natural, and physiological, thing to do at that point would be to panic. And the autonomic stress response would be there to aid and abet the panic by activating the entire sympathetic nervous system and by dumping epinephrine into the blood stream.

What Leno did involved an amazing bit of self-control and self-discipline. He remembered what he had been taught as a teenager about recovering from a spin, and he repeated the formula to himself at the same time that he followed his own instructions with his hands and his eyes. That formula is to "look where you want to go; steer where you want to go". It worked. He recovered from the spin, and didn't pack-in the prototype supercar.

A more dramatic example comes from Captain Chesley "Sully" Sullenberger's now famous landing of US Airways Flight 1549 on the Hudson River on January 15, 2009. Almost everyone knows the details. What is not widely known, however, was a cryptic comment that Captain

Sully made while he was revisiting the route with a reporter in a helicopter. He stated that while he was landing, he had to simultaneously keep his eye on the river and on his instruments. Any dip of a wing or deviation from horizontal could cause the aircraft to cartwheel on impact with the water and kill everyone on board.

Remarkably enough, Captain Sully reported none of the usual features of the stress response that we covered in the first lecture: no auditory exclusion; no tunnel vision; and no time distortion. What he *did* report, though, was a continuous verbal interaction between himself and: 1) ATC; 2) his crew; 3) the passengers; and, most importantly, 4) *himself*. In fact, while in the helicopter weeks later, he related to the reporter that he maintained the plane's attitude by repeating to himself the verbal directions to look in a sequential loop, back-and-forth between the "horizon", "instruments", "horizon", "instruments". "horizon", "instruments" until he safely landed the plane.

To a physiologist, what Jay Leno and Captain Sully did was this: The external stimulation (threat) was huge, and the internal effect (stress response) was impossible to prevent initially. The L.C. was activated as part of the sympathetic response; and this, in turn, activated the rTPJ (External network); which, in turn, reoriented the Internal network to redirect valuable attention away from the task at hand and toward the variety of stimuli for panic (e.g., the rushing walls at the race track; the rushing Hudson River; the panic in the voices of the passengers or crew). Both Jay Leno and Captain Sully overcame this automatic response by: 1) consciously referring back to training; and 2) talking themselves through the steps to recovery.

Just as Grossman's breathing exercise serves to push away his distracting puppy, so, too, does the mental activity associated with verbal commands – either aloud or internalized. In essence, the verbal activity not only projected up onto the screen of consciousness just the right tactic at the right time, but it also suppressed the External network and kicked the puppy dog away to allow the Internal network to regain control and reorient attention back to the best plan: the very same instructions that they were rehearsing mentally. In other words, the "verbal override" killed two birds with one stone: 1) it provided the right plan at the right time; and 2) it suppressed the L.C. and External network (rTPJ)'s distraction.

What about the tactical operator? One of the greatest risks in a fight to devote too much attention to the wrong thing (either to panic or its symptoms itself, or to a single weapon or assailant) for too long, and to miss other threats, or to freeze up in the middle of an otherwise well-executed plan. Locked attention ("perseverating") also prevents the operator or combatant from following through with the recurrent feedback loops that make up a fight. This allows the opponent to work within the operator's reactionary gap rather than *visa versa.*

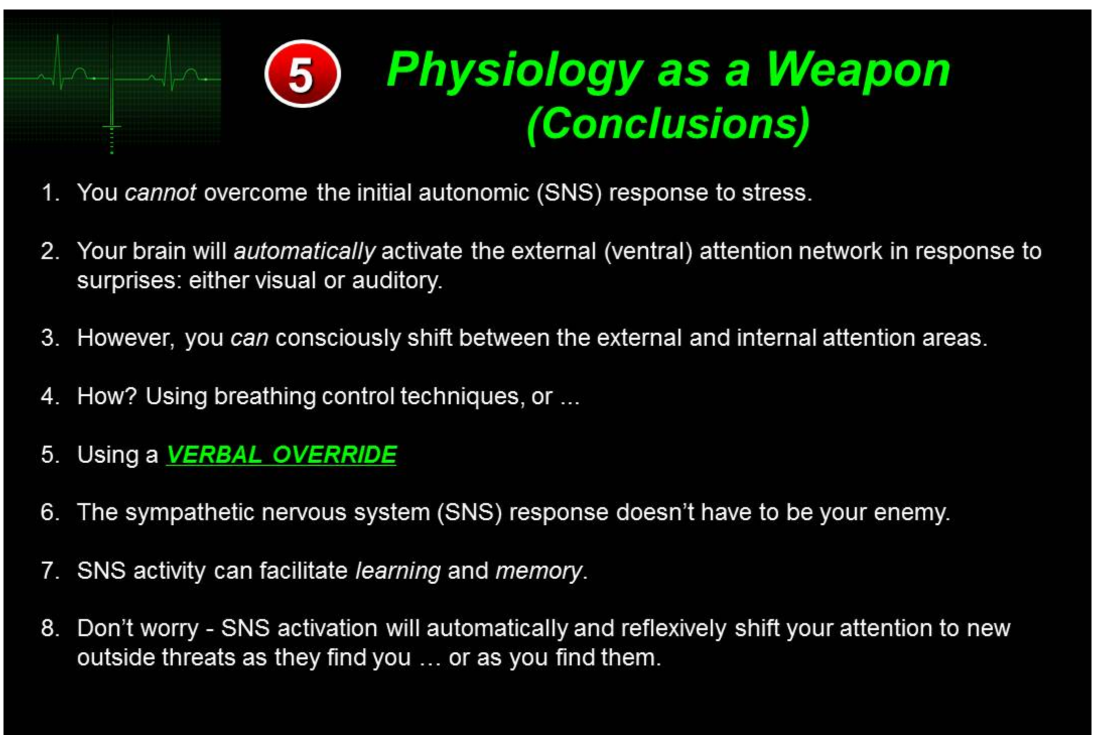
Verbal override accomplishes the same thing that tactical breathing does, but it also adds a front-and-center attentional shift to an instructional set that can save the day (in other words, during verbal override, attention is shifted to a plan for winning, but during tactical breathing, attention is shifted only to a plan for breathing). Finally, verbal override makes use of what we now understand about the way the brain distributes and shifts attentional focus.

Specific examples relevant to tactical tasks will be presented during lecture. To summarize the basics of verbal override, however:

1. Training before the fight is paramount. Leno had his old high school instructions to fall back on. Captain Sully had his previous training as a simulation instructor to fall back on. The verbal "script" used in verbal override has to make sense and be a time-proven and effective tactic for the situation at hand. This is the result of effort, work, sweat, and realistic training.

2. The operator needs to recognize that his stress response is happening, and/or recognize that he has just entered a rapidly changing, complex environment.

3. Instead of either freezing, or "winging it", the operator talks himself through the sequence (either out loud or to himself – depending on the context). It is important that the script take into account contingencies. For example; once one threat is recognized and dealt with, the script must call for an immediate scan for additional threats. The right script actually makes the operator more, not less flexible and responsive to changing threats



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