

Attention versus Skill

...the primary purpose of human cognition is to select constraints to reduce task specific behavioral alternatives. Attention is required for constraint selection when there is no skill for a task.

—Anthony J. Aretz [1]

Our central nervous system is finely structured functionally. All of our perception is pattern-based. Learning is essentially a process of building patterns. Genius, it was once said, is the faith that behind the confusing complexity of the cosmos are simple patterns (such as $F = ma$ or $E = mc^2$). All skilled movement is patterned. Some fairly complicated movement patterns are built in – when the newborn is placed at breast, it seeks for and feels the nipple, latches, on, and skillfully extracts milk. Other complex movements are acquired only with careful instruction and diligent practice – ballroom dances, organ playing, tying a double Windsor, landing a taildragger in a gusty crosswind.

Some movement patterns require both skill and precision, particularly performance arts. One of the reasons we watch music, dance, and athletics is that people are doing things that are impossible for the rest of us. These skills are difficult and time-consuming to develop, and degrade under stress: performance anxiety or fear of a threat. Stage fright, the athlete “choking,” freezing, or overreacting in an emergency are examples.

Research on learning has shown that how we pay attention to our skilled movements affects how fast we learn, how skilled we become, and whether our skill degrades under stress.

Disclaimer. The three people who regularly read this column have surely figured out already that when I discover something about aviation physiology that interests me, I then write a column while learning more about it. Sometimes, honestly, I keep reading for weeks after the

column is put to bed, and two months later, when this magazine lands in my mailbox, I cringe slightly at myself. You may cringe, too, if you wish, but you have to admit that you’re getting your money’s worth. Your contract with me is not performance based :-)

When I began this column on the fascinating connection between skill and attention, I discovered a large body of research that’s new to me, which, as usual, can’t be fully digested before the deadline. My penance is to list the source text at the foot, which will tell you the nuances in great detail if you’re captivated. It’s not the last word, but it’s thought-provoking.

Percy climbed awkwardly into the front seat of the glider for his first lesson, scared and excited. He wasn’t scared of dying – he was scared of the instructor discovering how clumsy and ignorant he was.

The instructor flew the tow to a comfortably high altitude, telling Percy to keep his hands and feet on the controls and “follow” his own movements. Percy did this, yet was puzzled. It was obvious that he could get out of this an idea of proper control movements, but there was no feel, just the instructor’s resistance. He wondered what the controls felt like without those heavy boots, those strong hands. He wondered if he could ever remember the proper positions and mimic them.

They released from tow, and the instructor demonstrated some shallow turns and level flight. It was smooth and easy. Percy let himself relax. He let his mind drift a bit, to the wonderful sensation of flight and the view of the ground.

Abruptly, his reverie was broken when the instructor said, “Your glider. Let’s just fly straight and level for a minute or two here. Keep the wings level, and use the stick to keep the airspeed on 50.”

Percy took over. It was as if the air had suddenly become more turbulent. Each foot, each hand seemed to have a mind of its own. He’d read about the effects of the controls, and understood. But he hadn’t anticipated that everything happened

at once. The glider would tip; he’d move the stick. However, while he was doing that, the nose would drop. He’d pick up the nose, and the yaw string would blow to the side. Then he’d step on the wrong rudder and make it worse.

Too many details to keep track of, corrections needing to be made faster than his brain could process them. He tried to focus harder.

Attitude controls airspeed. OK, he thought, But what to do when I’m fast and the nose is high?

Coordinate your bank; keep the yaw string straight.

The string, for no good reason, was pointing at his right shoulder and the left wing was tipped down. He tried to remember whether he was supposed to step on the head or the tail of the string, and while he was puzzling this out, the nose dropped and the airspeed increased.

In back, his instructor kept up a steady stream of commands. “Level your wings!” “Left rudder!” “Watch your airspeed!” Each barked command interrupted something else that Percy was focused on. He had to get back to airspeed before the wings were level, step on the rudder before airspeed settled down, then level the wings again. He couldn’t imagine trying to land! The true meaning of “coordinate” hit him: “too many things to keep track of.”

After a while, he was confused and exhausted, his pits drenched with sweat. It felt like a great gift when the instructor finally said, “My glider.”

Percy decided to go back to tennis.

But he didn’t.

Months later, with tennis still on the back burner, he released from tow and banked smoothly into the thermal they’d just hit. The controls felt sweetly balanced. He watched the clouds, checked for other traffic, and glanced frequently at the panel. Best of all, the vario kept chirping happily all the way through the turns.

What Happened to Percy?

In a nutshell, he stayed with the program, despite that clueless and annoying first instructor, and he *acquired skill*.

Like everyone learning a complex new skill, at first the details were overwhelming. This was made harder for him by his instructor shouting distracting com-



mands about each of the details that kept slipping out of his grasp.

Nevertheless, when beginning to learn a new skill, we do have to pay attention to the details of posture and motion, to learn proper technique.

The beginning pianist plays one . note . at . a . time. The skilled pianist sees and plays an entire scale, or arpeggio, chord or phrase. The change that has occurred is to have acquired *patterns* of perception and *patterns* of movement that have been linked through training.

Whatever the performance skill, there are parallel threads, which come together in early training. In dancing or on the piano, correct technique – posture of body and arms, position of fingers – is important for determining how well difficult passages can be handled at more advanced levels. This requires attention to detail.

Similarly, hearing music evolves from perceiving sounds to understanding patterns. Reading music progresses from seeing notes to understanding composition.

In each of these threads, the pianist goes from paying attention to detail to paying attention to the pattern.

In the aircraft, managing the three-dimensional vector, planning to arrive at a point in space, managing energy, supervising an engine if there is one, observing the vectors of other aircraft, staying oriented geographically, communicating with others, remembering the rules – all this is simply too overwhelming for the novice.

Nevertheless, with understanding instruction and repetition, the brain steadily builds patterns of motion, action, and perception, reducing hundreds of detail decisions to a handful of purposeful ones.

It seems that a key to the most effective training is understanding how to teach technique (attention focused inwardly) and *how* and when to transition to context and effect (attention focused externally). With a musical instrument this is a transition from reading the notes to making music. For an athlete, this is the point at which “the game slows down.” For the pilot, it’s the point at which the head is comfortably “out of the cockpit.” Some people never make this transition. Those who don’t make this transition are

more susceptible to choking, freezing, or stage fright.

One of the controversies about training involves the balance between directing the student to attend to details (movements, posture, actions, status) versus attending to outcomes (patterns, results, goals).

An interesting research finding is that paying attention to details helps the beginner and hurts the expert. With skilled performers, in either music or sports, the details have long ago become unconscious. If you ask the tyro golfer to describe his last putt, you’ll get all the detail. Ask the pro, and she won’t be able to tell you what her fingers and arms were doing, but will know all about the lie and the roll of the green.

It turns out that “choking” is related to the pro turning attention from the patterns to the detail, which turns off the automaticity that long years of practice built up. Performance anxiety can affect anyone, often unexpectedly. It distracts attention from the effect of action (external attention), and focuses it on movement detail (internal attention) that had become subconscious through training.

A Paradigm for Training

Gabrielle Wulf has done extensive research on coaching, practice, and their effects on performance excellence. She has found that experts perform best, and *learning is faster and more durable*, if an external focus of attention is used rather than an internal focus. Attention to the movement elements hinders the acquisition of skill – best motor skill learning occurs when attention is focused on the movement *effect*. [2] [3] This work implies that the student’s attention should be focused externally from the beginning, and the details of technique built within this.

A limitation of her work is that “internal” and “external” are vaguely defined; however, it appears clear that, aside from laying a foundation of correct technique to ensure well-coordinated movement, motor learning and performance is best if our attention is in some way focused on the result of our action rather than details of the movement.

We can infer from her work in sports that once the details of proper technique are understood – posture, hand and foot

position, sequencing – that we pilots do best to focus purely on the results we want to achieve.

For example, as a 16-year-old novice pilot on a windy and turbulent January day, I ignorantly tried to pay diligent attention to what my hands and feet were continually doing, trying to react instantly to every ripple in the air, to achieve the smooth flight that my instructor demonstrated so effortlessly. We banged and bumped along through the wrinkled air, yoke all but vibrating in my hands; then he took over, and flight was suddenly smooth.

The quotation in the title is this month’s *jargon treat*, and relates to this. Translated, it means that the novice pilot has to pay attention to each foot, each hand, and each of the four dimensions (time, and therefore velocity, is the fourth). The skilled pilot needs to pay attention only to status and goal.

Years later, I came back to aviation, and a wiser instructor taught me to fly attitude. *The bumps will average out; it won’t help to correct them.* The value of this became engraved the day I took off in a crosswind thunderstorm gust after visiting the same tree-lined grass runway where I’d begun that January lesson 17 years before.

Do pilots “choke”?

First, let’s agree on what choking is. (I wrote this two months ago, so your actual agreement is beside the point. I mention this just so you know that I know this sentence is purely rhetorical.)

Choking is turning our attention, under severe pressure to perform well, from *the external* (movement *effects*) to *the internal* (movement *details*). This severely degrades performance, whether it’s at the lectern, at the keyboard, on the court, or in the cockpit.

Severe performance pressure is not enough. Action-focused performance fear is required. The coach, sending players out for the big game says, “Just have fun,” to immunize them. The conductor who says to the soloist, “Let them hear the music” and the pilot who recites, “aviate, navigate, communicate” under stress are each working to focus attention on effect.

This is why a pilot may do less well in a check ride; this is a reason why a compe-



tent instrument pilot may lose control in turbulent IMC. Ironically, in an upset at altitude, we'd usually be better off opening the spoilers and letting go all the controls; arms folded, feet on the floor. More than once a pilot has bailed out and then watched the aircraft sort itself out and drift to earth.

One way we handle this risk in aviation is to train for emergencies. It's not just a truism; it's been shown pragmatically,

that in an emergency a pilot will perform as trained. If he's trained to do nothing, freezing or random action occurs.

How Should we Train?

My own thinking is that this means we should teach the pilot correct *techniques* outside of the cockpit, with no time pressure, ideally in a simulator; or in an ideal situation in flight. After technique is understood, we should focus the

student's attention on the outcomes of *actions* rather than the mechanics of actions in the cockpit. Precision should be set aside until the student has enough skill to achieve it without fixating.

Alternatively, to put it the other way, if the student fixates during a pilot task, this is a signal to take more time; to lower the standard and to work on skill until fixation is unnecessary. In my experience, a barrier to doing this is the expense of the extra time: the instructor may not have the time immediately available, and the student may feel it's not affordable financially.

However, more often, both student and instructor feel that fixation is dealt with best by forbidding it. Fixation is commonly seen *as a failure* of technique (failure to keep a scan going, for example) rather than what it is, a lack of skill (or an unintended abandonment *of skill* due to choking from performance anxiety).

How can we assess ourselves?

We can use these concepts, I think, to refine our own skill. If I find that I am thinking consciously about the position of the rudder pedals or stick, I need more practice.

In this practice, I first focus on proper technique without trying to be precise, but take note of the effects of change in technique. After I find an efficient and comfortable technique, then I focus on feel of the air, the response of the glider, and the effects of thinking about glider movement. Over and over.

This change in attention has become part of my scan, and is, I think, what people have *taught for years: keep your head* out of the cockpit (external focus, attention on effect) checking internal details *intermittently* – keep your scan going (airspeed, yaw string, flap position, etc.). The details of the scan are a steady cross-check that verifies the accuracy of our intent.

Instructors

Are you a CFI-G? Perhaps you're already aware of these issues. I hope this idea helps strengthen the good things you are already doing with your students.

Perhaps the best way to strike a balance between internal and external attention might be to teach techniques piecemeal, ideally in a simulator, other-



wise in flight with the instructor managing the flight: everything but the technique being taught.

Perhaps the only way to know whether the best balance is being struck is for the instructor's attention to be focused outwardly – on the student's performance, which is the instructor's effect, rather than inwardly, with the instructor trying to adhere to proper instructional methods.

Practice

A question beyond this month's deadline, one better answered by an experienced instructor, is how much practice is minimally necessary? This is a question for both student and instructor! How frequently should the student fly (or use the simulator) to be able to build and retain a skill? My experience is that it should be pretty often, at least twice a week. However, this opinion is not research-based! (It's totally idiosyncratic, actually.)

Similarly, how often *should* an instructor instruct, to maintain effectiveness?

As a corollary, how much diverse *pilot-ing* or instructing experience should an instructor have? I have a strong preference for the old, grizzled instructor who has interesting tricks to show. The green instructor, in my experience, doesn't have the breadth to bring a new pilot to a high level of skill.

In any case, the instructor should be flying a lot as well as instructing often.

I confess to another opinion not based on research: I always counsel student pilots to *seek instruction* from multiple instructors. Others often object to this, claiming (with no evidence whatever) that the differences may "confuse" the student, or the "lack of continuity" will slow progress.

My own experience is the opposite: the variability among instructors helped me understand what really matters, which things were a matter of style and, which were important for skill. This is called "generalizing" a concept. And I think continuity is overrated. The instructor who brought me to my private rating

many years ago could never remember what we had done the previous lesson without reading his notes in my log. In any case, the student really needs to take charge of his or her own learning. The best continuity comes from within.

Notes

[1] <http://oai.dtic.mil/oai/oai?verb=getRecord&metadataPrefix=html&identifier=ADP006941> Aretz, Anthony J Attention and Skill. Air Force Academy, Colorado Springs, CO, 17 April, 1992.

[2] Wulf, Gabriele. Attention and motor skill learning. Human Kinetics, Champaign, IL, 2007 ISBN-10 0-7360-6270-X.

[3] Wulf, Gabrielle. Attentional Focus and Motor Learning: A Review of 10 Years of Research E-Journal Bewegung und Training, 1 (2007), 4-14 http://www.sportwissenschaft.de/fileadmin/pdf/BuT/hossner_wulf.pdf

This journal issue presents collegial debate on Dr. Wulf's hypotheses. ✂