PSYCHOLOGICAL vs. AERODYNAMIC FORCES

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The purpose of this article it to point out a few of the psychological factors that can make your muscles do things you have been taught not to do. We will not cover all that have been identified in accident reports, but will use a few examples to point out how they work.

If you were to you look up all accidents involving "engine-failure-on-takeoff" where people lived versus those where people died, the main difference is that in the former, the pilot flew the aircraft to the crash scene. In the latter, the airplane stalled and spun to the ground one quarter of a mile to the left of the extended runway centerline. We see this over and over again – one quarter of a mile to the left.

Obviously these pilots had been taught how to recognize and recover from stalls. Yet the inevitable "forced" landing caused them to want to go back to a safe place - the safety of the runway. The surprise and seriousness of the situation, and the gushing adrenalin caused them to pull the elevator when they should have pushed, and push the rudder when they shouldn't have. How do our emotions make us do what our minds know is dangerous.

Let's look at the mind-set at play in this case. There you are, starting out on a family vacation, thinking ahead to the fun you'll have and the perfect landing at your destination. As you start enjoying this buoyant feeling, ***the engine quits.***

"Oh Sh(my goodness)!" You can't believe it. It has always been so reliable. Your mind goes through a short period of denial until you realize that you are not going to Kansas anymore. You automatically turn left because you can see better in that direction. Your grip tightens on the yoke. Your bicep – along with all your other muscles – tighten - ***causing a slight up elevator.*** You want to turn as fast as you can back toward the airport, but you don't want to bank too much or will lose vertical lift. ***This results in too much up-elevator, left rudder and right aileron.*** Then it happens. Your nose and left-wing drop abruptly toward the ground - less than 400 feet below. The ground rush causes you to pull back more on the yoke. In spite of all your stall practice, you have inadvertently stalled and spun in.

We are not immune because of thousands of hours of experience. Our training emphasizes the control and recovery from a stall, but without considering scenarios such as this. Psychological pressures will cause you to do things that you would not do on purpose. We all know not to stall while turning base to final, but every year well-trained pilots spin in on that turn.

Looking back, I remember several incidents in my career where I was a victim of some of these forces. Luckily – as you can see – I have survived. Of all the psychological factors have been identified as contributors to accidents, I would like to focus on just three:

- Alarm: "I don't know how I got here, but I know I shouldn't be."
- Population stereotypes: "Everyone does it that way."
- Distraction: "Why is that bird flying upside down?"

In the words George Santayana, "Those who cannot learn from history are doomed to repeat it." It is infinitely better to learn from others experiences than your own. I would like to offer some vicarious experience to illustrate each of these factors with some real world stories. Some are from other's experience, but unfortunately most are my own near-misses.

ALARM: I SHOULDN'T BE HERE

Desert Airport

I was building cross-country time for my commercial. I took a friend on a two-hour flight to a desert airport on the east side of the mountains. The west end of the airport ended at what looked like a river delta of rocks, sand and gravel which washed down out of the mountains. The dirt strip was about 3000 feet long. As I entered the pattern it looked like somebody had spun circles in the sand down the center of the runway in a dune buggy. I decided to do a low pass to see how deep they were. I had slowed to Vx (best angle of climb speed) so I would have time to see everything.* I flew about 50-feet above the runway, off to the side so I could see. It was obvious that the runway was soft sand and we shouldn't land.

*This, by the way, is a bad idea. You can see perfectly well at 150 kts and will have a lot more energy to zoom-climb over any obstacle. At 50- feet and 150 kts the flow rate looks just like it does in your car at five-feet at 15 kts.

As I neared the far end I realized that the delta material was flat, but not level. The debris had washed down out of the mountains over the years forming a steep outflow. I started a Vx climb no more than 40 feet above the rocks and gravel. Every time I looked at my airspeed I seemed to be one or two knots below Vx and I had to ease the nose down to gain speed. This cost me about five-feet each time. Each time I threw in some forward trim to help. Because of surrounding terrain, it wasn't until I had gained over 200 above the airport elevation (and by now about was down to ten feet above the rocks) that I could turn crosswind.

I had kept adding forward trim because it felt like I was pushing to keep the nose down. At some point I ran out of forward trim, and it still felt like I was pushing! When I checked it on downwind I realized that I had been pulling back about 25-30 lb. of back pressure! My biceps were trying to keep me out of the rocks. The impending danger of the rough terrain was telling my body to pull up, but my brain won the battle and we maintained close to Vx. If I had not been paying attention we would have slowly flared and landed (or stalled) up there in the rising delta.

Low Powered Go-Around

On another occasion my student was nearing the flare for landing at a 2500 foot long grass strip when I noticed an airplane flaring at the other end. I yelled at my student to go around. He jammed the throttle forward and only half of the cylinders responded. The sputtering engine allowed us to maintain about 50-feet of altitude, but not climb. With my vast experience, skill and responsibility I quickly took control and found the lowest gap in the trees ahead. I turned a modified left crosswind through the gap and over a harvested corn field. I turned downwind

toward the harvested field just beyond a stand of 80-foot pine trees. I was able to find a gap in the trees at the far end and turned onto a perfect short final for the airport.

After a normal landing we debriefed the incident. My student said "My only question is why you skidded around the first turn?" "Skidded?" I asked. "Yeah, the ball was all the way out to the right and I thought maybe you had a good reason for doing that." Actually I had intended to keep the ball in the center. Instead I had set us up for a spin at 50-feet. My body was telling me not to lose vertical lift, or maybe not to catch a wing in the trees. Luckily my mind concentrated on airspeed control and we had enough energy to maintain our 50-foot ground clearance.

Orange Grove Landing

Two of my friends were killed separately making forced landings in orange groves. Both went in vertically. If they had flown the aircraft into the top branches they would have survived. I am sure that the thoughts of the damage that was going to happen to the airplane caused them to subconsciously try to delay the inevitable.

Bob Hoover once said, "Fly the airplane as far into the crash as possible." Accident data shows that if you do that, you will probably live. If you stall before that, you will probably die. If you land in the trees, you will probably not be able to re-use the airplane, and you might have a difficult time getting out and down, but you will probably live. Both of my friends stalled out and spun into the orange trees vertically.

When you start the engine, you have every intension of bringing the airplane back to its parking place. When something happens that makes it no longer possible, we all delay switching to the survival situation. Reaction time is delayed by at least a second and a half. Captain Sullenberger did a masterful job of flying his jet as far into the water-landing as he could. Because of that, everyone aboard lived. He admitted to an instant of disbelief when the engines quit, but immediately went to the task of getting the nose down and choosing the most desirable outcome and doing what was necessary to make it happen. "We're going to be in the Hudson." His best option was a busy river with chunks of ice the size of cars. He knew that his choice was going to end in a drastic survival situation. He flew his A320 to a gentle wings-level splashdown among the boats and ice chunks.

Locked on the Controls

Fortunately I had a few hundred hours as an instructor when the pro-football linebacker spun us out of a stall. As the left wing dropped, he tried to raise it with full right aileron. The additional angle-of-attack fully stalled the left wing. My reaction was to counter him on the controls, but I couldn't overpower him. Fortunately my voice was reasonably calm when I said "I've got it." and he let go. I knew I had to neutralize the ailerons and push the right rudder. I have to say that turning the wheel to the left when in an 80-degree increasing left bank goes against everything my body was telling me. After we recovered, I looked at the 6'4" 250 pounder and said "I'm glad you let go when you did." He said "What you said made a lot of sense." I think he might have fought me if I had screamed.

Here Comes the Ground

I had been soaring back and forth along a ridge and was about to reverse course and turn the glider toward the airport. I tried to go a little farther past the end of the ridge and got into heavy sink. I could see my flight path taking me to the lumber yard at the base of the hill – now less than 500-feet below. It took a heavy conscious effort to keep the stick forward and dive for the lumber yard as I turned back to find the lift. Boy did it feel good when I found it. My body tried to tell me that I should keep my distance above the lumber yard and I had to consciously push forward to keep from stalling.

Here Comes the Ground!!!

I lost a friend who stalled at about 200 feet. He was towing a glider that made an abrupt pitch-up at about 200 feet because of a distraction. As the glider pilot released and turned back to the field, he said he last saw the tow plane in a 10-degree nose down attitude. The glider made it back to the field, but the tow plane did not. I am sure he saw the ground coming up and pulled up into a secondary stall. We later tried a stall and a secondary stall at altitude in the same type airplane. We lost 400 feet.

A common thread in these examples is that the intensity of the threat causes us subconsciously to deviate from what we have learned. We get to the edges of our experience and try to invent a solution. The threat takes a great amount of our attention from the task of physically flying the airplane, and subconscious survival skills take over. The take-away from this is to be sure to bring your flying skills to the alarming situation.

POPULATION STEREOTYPES

The science of Human Factors Engineering has made great strides in the past several decades to design controls that match population stereotypes. Population stereotypes are either subconscious "natural" ways to do things or reactions learned so early that they seem natural. We read from left to right because our mommy read from left to right when we were children. Red means danger because we associate red with blood. I came up against a population stereotype when we had a grease fire on our stovetop. My wife had left the French toast for a few seconds to tend to one of the kids, and when she came back the grease was blazing halfway to the ceiling. I shoved a towel into the dishwater and laid it flat across the top of the skillet. Luckily that stopped the flames, but there was still a lot of smoke. I reached up to the burner controls to turn them off.

Now here is where the population stereotype comes in. The burner controls were aligned from left to right across the top of the stove. There were four discrete sections of five push-buttons each representing the burners. Each set had a white button on the left of four black buttons. From the alignment, I could not tell which set controlled the offending burner so I pushed all the white buttons. I must admit to having very little experience in controlling stovetop burners, but

it seemed like the white one on the left should be off. I then grabbed the wall phone and dialed 911 to get some help. Just before I hung up and ran out of the smoke-filled house, I noticed that all of the electric spirals were starting to glow bright red. I carefully read the word "OFF" under the last black button on the ***right*** of each section and pushed them. The population stereotype tells us that "low" is on the left and "high" is on the right. Additionally, if any button deserves to be a separate color – it should be "OFF." Subsequently there has been quite a lot of study on how to take the ambiguity out of stovetop controls.

Older Airplane Designs

Control and instrument design features in older airplanes often went against population stereotypes. Engineers put instruments where there was room rather than where the pilot could easily find them. One early retractable-gear airplane had all electrical switches faired into the bottom of the panel in art-deco styling like little aluminum piano keys. The only difference between the landing gear switch and the flap switch was the name on the panel.

Many people fell into the trap explained by one pilot after sliding to a stop on his belly. "I knew it was time to raise something, so I raised something." Engineers have subsequently designed these switches to look and feel completely different. The landing gear switch looks like a wheel and the flap switch looks like a flap. Locking pins must also be moved to raise the gear. In addition, the layout of the six basic flight instruments has been standardized into the Basic "T" with the airspeed, horizon and altimeter across the top row and turn-needle, heading indicator and vertical speed indicator along the bottom.

Stall or Fall

One of my students was nearly ready for his private check ride when I asked him to do a power-off stall. During the stall, the left wing dropped and the nose followed. He kept the stick back and stood on the LEFT rudder. After a one-turn spin, I took over and recovered. He had developed a fear of spins during the later stages of his solo practice and could not talk his body into practicing stalls by himself.

He knew intellectually what to do, but he emotionally went back to the population stereotype of "falling left - step left" from his early walking lessons. After several remedial lessons he gave up learning to fly - to my continued regret. After his first few lessons I thought he was competent to practice stalls by himself, but he didn't.

Designing controls to conform to population stereotypes has commonplace with such events at the Three Mile Island nuclear accident where critical instruments and their controls were placed where the designers made them convenient to the building contractor rather than where they were most convenient to the operator.

The important thing here is to recognize when something is designed to go against your stereotype, and make a mental note that it could cause a problem. You may mitigate the risk by taking a few minutes to practice doing the right thing every time you encounter it.

DISTRACTIONS

A perfectly beautiful flight can cause a wonderful sense of euphoria as we approach our final destination. You probably made your worst landing at your home base after returning from your first successful SOLO CROSS COUNTRY. I was flying our family to visit some very good friends who had moved away to attend school. By this point in my career I had proven myself to be a consummate aviator as a Gold Seal Flight Instructor with a brand new Airline Transport Pilot Certificate. Everything on this flight had worked out in our favor all the way along. My altitude control had been near perfect and the VOR stayed centered all the way. We could see the runway from 60 miles out. It was an old SAC runway about 12,000 feet long and 300-feet wide. At 7000 msl and about 30 miles out, I noticed that the airway coincided exactly with the ILS localizer. The glide slope was above and slowly came down as I approached. I asked if I could follow the glideslope and was cleared for the ILS approach. I was also cleared to land at about five miles on final.

What a beautiful way to arrive. For about 20 minutes I kept the needles centered for the longest ILS I had ever flown. As we approached the field boundary and prepared to land, the kids saw our friends van at the edge of the parking lot and started shouting "Look! There they are!"

I waggled the wings a little and saw their kids start pointing and jumping up and down. We touched down in a slight crab and bounced about 10-feet up. After two or three more bounces, we settled firmly onto the concrete and were cleared to "dribble to the ramp." My wife said "We've never done it that way before." Slightly chastened, this Gold Seal CFI and ATP expedited to the parking area and we ran to meet our friends.

Later when I had some time to kick myself, I thought "You stupid jerk. You are a better pilot that that." From that day on I decided that I should challenge myself on every landing. I decided to practice a short field landing as my normal landing. The logic was that a short field landing required precision and concentration. The touchdown should be at a specific spot on the runway. Besides, all jet landings are short field landings. We may not use maximum braking at some places such as an old SAC base, but the approach is the same. Airspeed control, flight path control and touchdown alignment must all be fine-tuned to arrive at the selected touchdown point at the slowest possible speed. I had been distracted by the joy we shared at seeing our friends. Other sources of distraction can come from an equipment malfunction, a sick passenger, a bee in the cockpit. …

Mouse!

One of my glider friends was just taking off on his first flight of the spring, and a mouse ran out from under the seat and up into his lap. Before he could stop his reaction, he had jerked the stick back hard enough to break the tow rope at about 100 agl. This could have been disastrous for both the glider and the tow pilot, but luckily his training took over and they got by with no damage. I have added a line at the bottom of my glider takeoff checklist – "Mouse." If anything surprises me on takeoff, fly the glider and release the tow plane.

WATCH OUT FOR THE INNER YOU

Psychologists have identified the "lizard brain" as the part that fights to the last breath for survival – ignoring all other personal, ethical or educational values. When we are suddenly faced with a situation that looks like it could cause us to die, we revert from "Women and children First!" to "Where is MY life jacket?" Therefore in any activity where immediate accurate and correct reactions are required, we must be over-trained in doing the right thing. Some say this overtraining should incorporate the expected emotional situation as well. I wholeheartedly agree, but find it hard to do. Filling the cockpit with acrid smoke on takeoff is frowned upon. Training scenarios can help mentally prepare for the adrenalin rush, but it will still surprise you.

This is not an exhaustive list of psychological traps that await us. This discussion is meant to prime you to watch out for a few big ones - the "lizard brain" the "population stereotype" or the "Mouse." Concentrate on flying the way you were taught.