From the Couch to the Cockpit: Psychological Considerations During High-performance Flight Training

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ABSTRACT

This paper addresses aviator performance, specifically facets of emotion management, during unexpected events in extreme airborne environments. Intervention strategies underpinned by cognitive/behavioral theory identify psychological techniques which may prove useful in high-performance flight training. As humans, various life experiences teach us that during an emotional moment, our ability to deliberately regulate our thoughts and behaviors becomes diminished. Normally, this reduction in functionality is not life threatening, however in the realm of aviation, the operational environment can quickly become extreme. If pilots are not well-prepared to counteract these natural tendencies, the consequences can be dire. The purpose of this paper is three fold. First, we lay out a scenario of what an uninitiated aviator might experience during a surprising event in an extreme environment. Second, cognitive-behavioral theories are contextually discussed which deconstruct aspects of surprise. Third, psychological techniques are identified which serve as intervention strategies, to integrate and manage affect and cognitions for the benefit of increased aeronautical safety.

INTRODUCTION

Most domains where humans work are characterized by some degree of uncertainty, in the case of aircraft operations, the manner in which one responds to uncertain conditions can be of considerable importance. Particularly, if an unexpected event is sufficiently serious, and/or arises during a critical phase of flight, the correct response to that uncertainty becomes vital for survival. It is during these situations that tolerance for errors are diminished and flight operations become extreme. In the following excerpt a pilot recounts the worst turbulence encounter of his 31-year airline career. This event occurred while on approach to Dallas-Fort Worth airport (McCollister, 2005).

> *Passing 10,000 feet, as I slowed our MD-80 aircraft to the airspeed limit of 250 knots, I turned to the copilot and saw concern on his face. He glanced from me to the fuel gauges, then to the radar display, and I told him not to worry, we had enough fuel. The radar's information was another matter.*

The radar screen was covered with bright red, indicating very heavy precipitation. Out the window he could see a significant line of weather rapidly approaching.

> *I was looking at the radar display, confirming separation from the front, when I felt a subtle shudder run through the airframe. I started to scan my instruments when we ran into a figurative brick wall. The MD-80 rolled violently to the right, almost reaching an inverted position. Simultaneously, the nose pitched upward almost 30 degrees. Severe turbulence pummeled the aircraft, shaking us so violently that the instruments became a smattered blur. The autopilot disconnected, and all of the audible warnings for the cockpit activated. I was barraged by the recorded female voice of the MD-80, calmly advising me of the engine fires, over-speed limits, flap failure, improper landing gear configuration and a host of other maladies. […] I responded to the unusual attitude by depressing full opposite rudder, and pushing the control yoke fully forward. The copilot helped me, and we both added our strength to the flight controls, frantically trying to regain level flight. The aircraft trashed and struggled in the maw of the turbulence. Like a leaf in the wind, we began to corkscrew downward. The altimeter began to unwind. We were falling.*
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> *It seemed to happen in slow motion. The frantic shaking of the aircraft, the flight to restore level flight attitude, the altimeter winding down through the numbers – all were happening in a time-expanded play. The constant, audible warnings came from far off, detached from the struggle in the cockpit. Suddenly, we warped back into real time. As we dropped through 3,000 feet, the rolling wave of air spat us into smooth air, and I immediately regained control of the aircraft.*

In this situation, flying into severe turbulence resulted in a state of surprise, among other emotions, for both the pilots and passengers. While on the surface it seems that there is little one can do in such a situation, field research shows that pilots who undergo *upset-recovery training*, (or a similar type of training program: i.e. emergency maneuver training, unusual attitude training, disorientation training, etc.) are in a better position to handle the crisis, particularly the prevention of cascading or exacerbating problems (Kochan, 2005; Woods & Patterson, 2001). Regulatory requirements for training pilots to respond to unexpected events, unusual attitudes, and/or upset situations which could lead to loss-of-control are inconsistent and in most cases vague. The only requirement for Federal Aviation Administration (FAA) pilot certification in the U.S. at the Private, Commercial, or Air Transport Pilot level is for the applicant to "exhibit adequate knowledge of recovery from unusual attitudes" (Federal Aviation Administration, 2002, p. 2-27). Operations under U.S. Federal Aviation Regulations Part 91, Subpart K, Part 135, and Part 121 air carriers are not *required* to provide specific upset recovery training. However, there are a number of *recommended* practices and training programs addressing the loss-of-control issue. The purposes of such specialized training are generally two fold; however, the objectives are not mutually exclusive. First, exposure to unusual operational conditions allows for the development or maintenance of rarely used skills. Second, the behavioral management of accompanying emotions promotes progressive functionality under conditions of great uncertainty and fear. It is this second objective that is often not addressed in traditional flight training (L. Hinchee, April 7, 2005 personal communication) and is therefore reasoned to merit greater emphasis.

BEHAVIOR MANAGEMENT: JUSTIFICATION AND THEORY

The Federal Aviation Administration (FAA) Aviators Instructor's Handbook (1999) recognizes the need for flight instructors to occasionally play the role of "practical psychologist", and offers basic information regarding the analysis and evaluation of personality. Their brief coverage of anxiety and stress response as it is applied to decision-making, underscores the notion that these factors are relevant to aviation instruction. However, the details of "how" and "why" the instructor implements these psychological skills are lacking. The FAA appears to only minimally address the issue of behavior management, via the Airplane Flying Handbook (2004) which suggests that pilots should *remain calm* during emergencies, but does not elaborate on ways in which the pilot can build coping strategies.

Thus the industry is left with pilots, and their instructors, who get into emotionally taxing situations without the ability to adequately rectify the condition. This trend of being "caught by surprise" and not knowing how to respond appropriately has been partially supported by pilot testimonials gathered from a recent field survey (Kochan, Breiter, & Hilscher, 2005). This survey identified contributing factors in unexpected events which lead to loss-of-control. It was reasoned, that some form of psychological processing would better prepare aviators for these rare but extreme events. The core psychological considerations which are felt to be particularly relevant to specialized training are discussed next. First, the psychological impact of surprise is deconstructed, and secondly psychological techniques are identified which may provide both inter-personal and intra-personal solutions to help reduce the negative effects of surprise.

Psychology of Surprise

A pilot can become surprised when some unexpected event(s) during flight contradicts their expectations. While the magnitude and particulars of an event may be unique depending on the pilot's background and situational context, suffice it to say that large discrepancies may lead to the breakdown of a pilot's mental picture, causing a loss of situation awareness. Kallus, Barbarino, VanDamme, & Dittmann, (1999) predict, that as long as there are no, or only small, discrepancies between anticipations and perceived entered situations, the mental picture and the combined mental model will be maintained. This general response is universal. We know that a person's behavior is always jointly determined by their personality and the situation in which they find themselves (Choi, Dalai, & Kim-Prieto, 1999). Thus, the impact of surprise is an outcome of the complex interaction between personality and situational factors. Furthermore, the degree of familiarity with these specific factors and individual differences will play a large part in determining how an aviator responds to unexpected events.

For the purposes here, an assumption is made about the chief psychological elements which correspond to states of surprise. Observational evidence in airborne environments (Kochan, Breiter, & Jentsch, 2004), showed that when something unexpected happens and a surprise reaction is triggered, this often results in an unpleasant affect and diminished operational performance. Due to these resultant affective states, part of the management strategy discussed here involves understanding the consequences of these feelings and behaviors in order to minimize their debilitating impact. And while research in cognitive psychology on this topic is extensive (Schutzwohl, 1997a; Wickens, 2003), our coverage is limited to those factors that (a) most directly pertain to aviator performance, and (b) lend themselves to manageable psychological interventions. Thus, we posit that the psychological aspects of surprise, and its effective management, are expressed in the following cognitive-behavioral underpinnings: alertness, sensemaking, updating, and the integration of emotion (Klein, 2003).

Alertness

Alertness is related to arousal levels. The well-known Yerkes-Dodson (1908) law posits that cognitive performance is greatest when a person is in a favorable arousal state. Performance suffers if the level of stress rises above or falls below the favorable level, (Mendl, 1999). This relationship naturally has implications for surprising events; such situations can place an aviator into such a highly aroused state they become rendered ineffective even at the simplest of tasks.

Sensemaking

Weick and Sutcliffe (2001) describe “sensemaking” as what happens when we size up situations. Operators need to make sense of the situation in order to anticipate how a proposed change in a plan is going to play out, and to determine what kinds of difficulties might result. In order to effect changes on the flight deck, one necessarily has to have some level of understanding of the situation. In other words, accurate cue perception needs to be taking place. In most operational environments, there are numerous cues that must be considered when performing required tasks. When operators are faced with a stressful situation, there is a tendency to reduce the number of cues that are sampled and therefore perceived (Wickens & Flach, 1988). This discriminatory allocation is referred to as selective attention, and while it is beneficial from a time/resource management point of view, operators sometimes allocate their attention poorly and consequently have an incomplete picture of the situation. This loss of stability can lead to a cycle of confusion that entraps the aviator and precipitates loss-of-control.

Updating Information

When the unexpected happens, for example an alarm sounds, pilots tend to pay closer attention to information related to a yet to be confirmed situation and try to make sense of it, instead of putting their energies into seeking-out additional information and keeping the "big-picture" in mind. This narrowing of attention is often termed *tunnel vision*, a phenomenon in which a pilot will not adequately perceive all pertinent information because of filtering based on preexisting expectations, initial impressions, or other undefined factors (Wickens, Fadden, Merwin, & Ververs, 1998). This restricted thinking increases the likelihood that sensorial stimuli and alternative scenario interpretations would only be considered if consistent with these preexisting expectations (Muthard & Wickens, 2002). Alternatively, by staying "in motion" (not fixating on any one thought) pilots update the totality of information and are in a position to engage in more efficient pattern recognition and analysis (van der Vlugt & Wieringa, 2002). This tendency to fixate is exacerbated by emotion and strong feelings that can distort the information updating process, thus pilots fail to use all of the information that is potentially available to them.

Integration of Emotion and Cognitive Control

By definition emotions are evolved situation-response tendencies that involve (a) subjective feeling states, (b) cognition and information processing, (c) expressive displays and behavior, (d) motivation, and (e) physiological responses (Diamond & Aspinwall, 2003). As previously mentioned, cognition and emotion are intricately intertwined constructs. This condition exists because individuals orient toward, perceive, and interpret external stimuli in the context of their motivational and behavioral significance (Compton, Banich, Mohanty, Milham, Herrington, Miller, Scalf, Webb, & Heller 2003). However, in the case of aviation, the cognitions that pilots hold may not always be sufficiently encompassing to include exceptional events. Due to the many redundancies in aircraft systems, the probability of an accident due to some unforeseen event(s) is relatively low (Amalberti, 2000; Reason, 1990). While statistically supported, this relative sense of safety can contribute to a mindset where one is not adequately prepared for sudden excursions into extreme conditions. When the pilot's mindset and emotional preparedness are less than optimal for a given event, this can lead to an outcome that is injurious, or fatal. For example, if a bird were to strike the aircraft leading to an engine failure, the sudden loss of engine power and triggering of many cockpit alarms may instantaneously bring a pilot's emotions to a saturation point. In such a scenario, information processing would almost certainly suffer. Research has shown that powerful emotions have the potential to disorganize and/or disrupt multiple psychological processes (Fox, 1994). However, by incorporating both intrapsychic and interpersonal processes in advanced aviation instruction one has the opportunity to understand and manage (self-regulate) these affective reactions.

Surprise, with its various cognitive-behavioral manifestations, can be subjected to psychological techniques and therefore, integrated into selected phases of aeronautical training for the purpose of mitigating its debilitating effects.

TECHNIQUES AS SAFETY INTERVENTION

Through the use of psychological techniques, an instructional environment can be created that teaches pilots how to react more effectively during exceptional events. The benefit of developing alternative reaction strategies would be to expand a pilot's repertoire of actions and coping mechanisms, consequently increasing margins of safety. The specific purpose of the following techniques is to help pilots and instructor pilots understand and integrate facets of emotion that are inherent to flight training. The goals of this intervention are (a) more effective cue monitoring, (b) fluidity in detecting change, (c) managing emotions generated by uncertainty, (d) evaluating situations, and (e) creating novel solutions by modifying and adapting known remedies. These outcome goals can be achieved using various methods borrowed from the fields of industrial and clinical psychology and strategically integrated into flight training syllabi.

The following is a description of three psychological techniques that are both intra-personal and inter-personal in foci, with the caveat that this listing serves as an exemplar and is neither complete nor specific to any training protocol. The techniques are paired with corresponding generic aeronautical examples to provide minimal context, but are neither exclusive nor exhaustive.

1. Imagery: The intra-personal skill of guided imagery has been shown to be facilitative in problem solving, making decisions, understanding verbal descriptions, and picturing behavior (Goleman, 1986). Research has shown mental practice to be an effective tool to enhance aviation performance (Jentsch, Bowers, & Salas, 1997). By performing "chair-flying" activities, such as engine out procedures, one can begin to create flying scenarios in the mind that evoke mild anxiety, all the while developing an attitude that unwelcome feelings are not valueless. It is through the use of imagery that the anxiousness of flying and other inter-personal barriers can be normalized. With guided imagery the student and instructor have the opportunity to address lapses in concentration, errors in execution and reflect on our self-inhibiting bad habits. A flight manual developed by the U.S. Navy (U.S. Department of the Navy, 1943) aptly puts it "the principal cause of difficulty in learning to fly, is simply fear of flying. It is certainly normal and natural to experience feelings of fear in situations of real or apparent physical risk" further "going through flight training is much more a matter of learning to control ourselves than it is of learning to control the airplane" (p.100).

2. Nonverbal Communication and Focused Listening: It is incumbent on the flight instructor to very carefully observe the body language of his or her student in order to recognize subtle changes in emotion that the student may or may not be aware of. These emotional cues are the physical movements one pay's attention to in order to derive meaning in communication. The cues used to form expectations and identify violations of these expectations in face-to-face communication are relatively consistent (DePaulo & Friedman, 1997). The observation of a trainee's performance under directed stress, and the subsequent interpersonal exchanges that transpire during flight instruction, serve as a window

into the emotional dynamics experienced. After the student performs an extreme maneuver, for example a spin, the instructor should discuss very specifically what visceral reaction the student just had. The U.S. Navy (U.S. Department of the Navy, 1943) writes “the healthiest attitude to adopt with respect to feelings of fear is to admit their existence freely while countering them with our predetermined ideas and purposes” (p. 103). By observing the level of uneasiness in both a verbal and non-verbal manner, feelings of fear will become more manageable. The following list from the Center of Nonverbal Studies™ (2005) describes what facial cues can mean:

- Nose: nostril flare (arousal).
- Lips: grin (happiness, affiliation, contentment); grimace (fear); lip-compression (anger, emotion, frustration); canine snarl (disgust); lip-pout (sadness, submission, uncertainty); lip-purse (disagree).
- Brows: frown (anger, sadness, concentration); brow-raise (intensity).
- Tongue: tongue-show (dislike, disagree).
- Eyelids: flashbulb eyes (surprise); widened (excitement, surprise); narrowed (threat, disagreement); fast-blink (arousal); normal-blink (relaxed).
- Eyes: big pupils (arousal, fight-or-flight); small pupils (rest-and-digest); direct-gaze (affiliate, threaten); gaze cut-off (dislike, disagree); gaze-down (submission, deception)

Focused listening, like careful body language observation, takes a bit of practice. The instructor needs to summarize what he hears and how it is being said. How are words being used, what is being emphasized, what does it sounds like? It is important to remember that most of what we convey to other people is not in what is said, rather, it is in how we say it. Together, both expression (facial, body posture, tone, intonation, etc.) and verbalization can offer the instructor and pilot an indication of how surprise and/or fear were experienced.

3. <u>Systematic Desensitization and Emotion-Regulation Strategies:</u> The classic behavioral technique of s*ystematic desensitization* involves reducing ones sensitivity to certain stimuli in a given anxiety-producing situation in very small, controlled steps. For example, in some advanced flight training programs, gradual levels of increased bank and attitude are used during initial maneuvers to minimize fear and stave off feelings of helplessness associated with unusual attitudes (L. Hinchee, April 7, 2005 personal communication). By progressively increasing the aeronautical challenges the student becomes gradually sensitized to extreme performance requirements and the associated affect which accompanies them. When back on the ground, it is important for the instructor not only to praise the student where appropriate, but also to discuss the student’s *emotion-regulation strategies* (internal dialogue) and how their view of themselves has changed as a function of the flight training. It is through the reflective discussion of the emotion-eliciting situation that the student’s internal and transactional processes can be reinforced (Eisenberg, Fabes, Guthrie, & Reiser, 2000; Gross, 1999). This self-awareness technique should translate to higher operational

functioning during crisis. The objective is to increase the student's capacity to emotionally reflect upon context-specific airborne challenges so they can generalize to unknown surprising events that await them. Thus, the goal of the flight instructor is to progressively increase the level of challenge while deconstructing emotion regulation strategies with the hopes of instilling greater self-awareness and confidence as the student's environment changes from normal to extreme.

CONCLUSION

Margins of safety can be increased when aviators hone both their instinctive and strategic responses to surprising events. The skills that are instilled during upset recovery training, which include behavioral management of accompanying emotions, can help aviators manage the unexpected with greater success when flying environments become extreme. This theoretical paper has shown that when aviators are not focusing on the appropriate part of the perceptual field and emotive reactions are imbalanced, results can be extremely dangerous. However, when underpinned by the cognitive-behavioral aspects of surprise, psychological techniques can be incorporated into procedural learning to enrich the scope of training. When flight training includes the integration of both inter-personal and intra-personal dynamics, aviators may be able to respond before suffering adverse consequences. The effective flight instructor can organize high-performance flight training to fit the psychological needs of the student, realizing that behavior is directly influenced by the way a student perceives events. Therefore, it is important for the instructor to facilitate the learning process by carefully structuring aeronautical challenges that precipitate loss of stability, while observing stress cues and helping the student moderate internal processes. It is reasoned here, that high-performance flight training should emphasize psychological considerations to help to manage perceptions and emotions, thereby maximizing pilot performance and increasing flight safety.

REFERENCES

Amalberti, R. (2000). The paradoxes of almost totally safe transportation systems. *Safety Science*, 1, 1-16.

Kochan, J., Breiter, E., & Hilscher, M. (2005). Surprise and unexpectedness in flying: A survey of pilots' perceptions. Manuscript submitted for publication.

Center of Nonverbal Studies (2005). *Nonverbal Communication.* Retrieved 08/22/2005 from http://members.aol.com/nonverbal2/nvcom.htm

Choi, I., Dalai, R., & Kim-Prieto, C. (1999). *Culture and judgment of causal relevance: Inclusion vs. exclusion*. Unpublished raw data, University of Illinois, Urbana-Champaign.

Compton, R.J., Banich, M.T., Mohanty, A., Milham, M.P., Herrington, J., Miller, G.A., Scalf, P., Webb, A., & Heller, W. (2003). Paying attention to emotion: An fMRI investigation of cognitive and emotional Stroop tasks. *Cognitive, Affective, and Behavioral Neuroscience, 3,* 81-96.

DePaulo, B.M. & Friedman, H.S. (1997). Nonverbal Communication. In D. Gilbert, S. Fiske, & G. Lindzey (eds.) *Handbook of Social Psychology*, 4th edition.

Diamond, L. M., & Aspinwall, L. G. (2003). Emotion regulation across the lifespan: An integrative approach emphasizing self-regulation, positive affect, and dyadic processes. *Motivation and Emotion, 27*, 125-156.

Eisenberg, N., Fabes, R. A., Guthrie, I. K., & Reiser, M. (2000). Dispositional emotionality and regulation: Their role in predicting quality of social functioning. *Journal of Personality and Social Psychology, 78,* 136–157.

Federal Aviation Administration (1999). *Aviators Instructor's Handbook* FAA-H-8083-9 Retrieved:08/20/2005, http://www.dynamicflight.com/avcfibook/

Federal Aviation Administration (2004). *Airplane Flying Handbook* FAA-H-8083-3A Retrieved:08/20/2005http://av-info.faa.gov/data/traininghandbook/faa-h-8083-3a-7of7.pdf

Federal Aviation Administration (2002). *Private Pilot for Practical Test Standards for Airplane.* FAA-S-8081-14A. Washington, DC: Flight Standards Service.

Fox, N. A. (1994). *The development of emotion regulation: Biological and behavioral considerations.* Monographs of the Society for Research in Child Development, *59,* (2–3, Serial No. 240).

Goleman, Daniel. (1986). *Emotional Intelligence*, London: Bloomsbury.

Gross, J. J. (1999). Emotion regulation: Past, present, future. *Cognition and Emotion*, *13,* 551–573.

Jentsch, F., Bowers, C.A., & Salas, E. (1997). Could mental practice and imagery be techniques for enhancing aviation team performance. *Proceedings of the 41st annual meeting of the Human Factors and Ergonomics Society*, 1172-1175.

Kallus, K.W., Barbarino, M., VanDamme, D. Dittmann, A. (1999). Integrated task analysis of en-route control: A process oriented approach. In: Jensen, R.S., Cox, B. Callister, J.D. & R. Lavis (Eds.). *Proceedings of the Tenth International Symposium on Aviation Psychology*. Columbus: The Ohio State University (S. 517-521).

Klein, G. (2003). *Intuition at work: Why developing your gut instincts will make you better at what you do.* New York: Random House, Inc.

Kochan, J.A., Breiter, E.G., & Jentsch, F. (2004). Surprise and unexpectedness in flying: Database reviews and analyses. In *Proceedings of the Human Factors and Ergonomics Society 48th Annual Meeting.* New Orleans, LA: Human Factors and Ergonomics Society.

Kochan, J. (2004). *Upset Recovery Training Effectiveness Progress Report.* Federal Aviation Administration Contract No. DTFA01-02-C-00088

McCollister, J. (2005). Approach into turbulence. *Airliners.* 94, 10-11.

Mendl, M. (1999). Performing under pressure: Stress and cognitive function. *Applied Animal Behaviour Science, 65*, 221-244.

Muthard, E. K., & Wickens, C. D. (2002). Change detection after preliminary flight decisions: Linking planning errors to biases in plan monitoring. In *Proceedings of the Human Factors and Ergonomics Society 46th Annual Meeting*. Santa Monica, CA: The Human Factors and Ergonomics Society.

Reason, J. (1990). Human Error. New York: Cambridge University Press.

Schutzwohl, A. (1997a). *Responses to affectively neutral, positive, and negative schema-discrepant events.* Manuscript in preparation, University of Bielefeld, Bielefeld, Germany.

U.S. Department of the Navy, Bureau of Aeronautics. (1943). *The Effects of Flight: Physical and Mental Aspects*. New York - London: McGraw-Hill Book Co., Inc.

van der Vlugt, M. & Wieringa, P. A. (2002). Is overcoming of fixation possible? In *Proceedings of the 21st European Conference on Human Decision Making and Control*. Glasgow, UK.

Yerkes, R. M. & Dodson J.D. (1908). The relation of strength of stimulus to rapidity of habit formation, *Journal of Comparative Neurology and Psychology,* 18, 459-482.

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the unexpected.* San Francisco, CA: John Wiley & Sons, Inc.

Wickens, C. D. (2003). Attention to safety and the psychology of surprise. *Proceedings of the 11th International Symposium on Aviation Psychology.* Columbus, OH: The Ohio State University.

Wickens, C. D., & Flach, J. M. (1988). Information processing. In E. L. Wiener & D. C. Nagel (Eds.), *Human Factors in Aviation.* London: Academic Press Limited.

Wickens, CD, Fadden, S, Merwin, D, & Ververs, PM (1998). Cognitive factors in aviation display design. *17th DASC Proceedings*, IEEE.

Woods, D. D., & Patterson, E. S. (2001). How unexpected events produce an escalation of cognitive and coordinative demands. In P. A. Hancock & P. A. Desmond (Eds.). *Stress, Workload, and Fatigue.* Mahwah, NJ: Lawrence Erlbaum Associates.