Training Pilots for Unexpected Events – A Neuroscience Approach

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The 10th IICIES will be held in Wellington, New Zealand

Bias awareness programmes

NZ Army (Sheffield, Margetts, Milward, 2017)

Co-author: Senior officer/commandant Cohort: Junior officers Domain: Battlefield management

Woman's Health (Murray & Sheffield, 2019)

Co-author: Surgeon/regional manager/academic Cohort: Professionals in woman's health: surgeons, midwives, nurses.. Domain: Obstetrics & gynaecology

Common elements

Check the trust bond (Mark Hughes: Is error admissible?) Cognitive bias and systematic error Modalities of thought Deliberate, creative switch of modalities (metacognition)

Critical reflection on decisive moments (Sheffield, 2016)...



"Select a problem-solving and decision making situation that you have experienced that is important to your development ..."



"Birth on your back - probably not as much fun as Ross thinks. Our obstetrician is known as a forceps man."



"Mr N is slowly dying. His blood pressure falls. I stand at the foot of his bed.. They all look towards me waiting for the decision."



"Like all Kiwi in the early '90s I had begun to witness the resurgence of the Ta moko (Māori tattoo) scene in New Zealand."



"My childhood was tough. Parents are weak and don't have kids' best interests at heart. I shouldn't pursue or expect happiness."







"I braked hard and heard (and felt) a loud crash as something slammed into the back of our car. My family yelled in shock. "What're you doing !!"

"I had lost 15 kg in two weeks and had not felt my feet for five days - but My Decisive Moment was yet to come."



. The aim is to reflect on that experience and gain deeper insight into it through the application of conceptual material."

My Decisive Moment Vol. 4

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Decisive Moment

Jim Sheffield

Volume 4

Startle!



How could I have been so stupid!! My own ongoing, anguished, critical reflections on a decisive moment.. Whiteout. We can't see way to hut. At 6pm we find footsteps. Now what? <u>Other side</u>?



Pilots

Landing on the Hudson: Sully

Managing startle & surprise through deliberate calm





"For 42 years I've been making small, regular deposits into this bank of experience, education and training. On January 15 the balance was sufficient for me to make a very large withdrawal." **Sully**



https://www.youtube.com/watch?v=m6EOj4cXzfw (3:10)

Landing on the Hudson: Jonah Lehrer

"The brain is like a Swiss army knife, it's stuffed full of all these different tools, these different ways of thinking."

"By using metacognition ("thinking about thinking") we can tailor the thought process to the task at hand."

http://www.youtube.com/watch?v=N2iJF2I94pg (2:34)

Training pilots for unexpected events

ICAO Safety Priorities

Per the ICAO Global Aviation Safety Plan (GASP) 2017-2019:

- LOC-I is one of top 3 in safety priorities
- Runway-related events and CFIT
- Represent 58% of total accidents, 80% of fatal accidents, 96% of all fatalities and 82% of hull loss
- LOC-I is associated with 'Startle'

Elements of training programmes

Flight school

• Classroom theory and practical flying exercises

Flying

- Practice in small aircraft
- Stick and rudder skills

Airline pilot

- Recurrency training including Line training and checks
- Simulated exercises, e.g., EFATO and debriefing
- Some research and studies on training from past events
- Auto-pilot, auto-pilot, auto-pilot

What's missing?

- Unpredictable and variable scenarios
- Realistic or challenging scenarios
- Managing startle and surprise
- Training pilots for unexpected events

Training pilots for unexpected events

Professional practice and concepts

Martin et al (2018). A training-centred approach to the situational awareness control model

Beveridge et al (2018). The captain as pilot flying may cause suboptimal monitoring, situational awareness and decision making

Dismukes et al (2018). Flight crew errors in challenging and stressful situations

Flin (2018). Non-technical (CRM) skills and a modicum of chronic unease may enhance safety performance

Matton et al (2018). Learning flight procedures by enacting and receiving feedback

Wiltshire (2018). Problem-solving phase transitions during team collaboration

Li et al (2018). Self-efficacy significantly reduced pilot error on a classroom selfreport

De Visser et al (2018). Learning from the slips of others: Neural correlates of trust in automated agents

Newton et al (2018). Building intelligent tutoring systems for teams

Training pilots for unexpected events

Concepts

Landman et al (2017). A conceptual model is proposed in order to explain pilot performance in surprising and startling situations

Rosenweg (2018). Evaluation of self-regulation skill may aid rapid attention recovery

Massaiu (2018). Conceptual models may guide pilot's expertise and enhance their resilience

Experiments in simulators

Casner et al (2015). Vigilance is impossible. Diligence, distraction, and daydreaming all lead to failures in a practical monitoring task

Casner et al (2014). Predictable/rote-memory simulator training results in inappropriate/varied performance in a surprise scenario

Landman et al (2018). Unpredictable/variable simulator training scenarios improves learning transfer/performance in a surprise scenario

A neuroscience approach

Landman et al (2017). Dealing with unexpected events on the flight deck: A conceptual model of startle and surprise



Figure 1. Conceptual model of startle and surprise. Solid lines indicate sequenced events. Dashed lines indicate potential influences, with plus signs indicating an increasing effect and minus signs indicating an impairing effect. Double lines indicate thresholds.

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Landman et al (2017) used the conceptual model to analyse four accidents



Figure 2. Estimated causal factors in the four cases as mapped onto the conceptual model of startle and surprise.

Landman et al (2017) concluded that interventions should focus on:

- 1. Increasing the supply and quality of pilot frames (e.g., though practicing a variety of situations),
- 2. Increasing pilot reframing skills (e.g., through the use of unpredictability in training scenarios), and
- 3. Improving pilot metacognitive skills, so that inappropriate automatic responses to startle and surprise can be avoided.

Kim (2018). The impact of metacognitive monitoring feedback on mental workload and situational awareness



Fig. 4. SA level-based Metacognitive monitoring feedback



Surprise ACC



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Figure 2. Estimated causal factors in the four cases as mapped onto the conceptual model of startle and surprise.

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"Startle" is managed by the conversation between what we feel and what we think

Three perspectives: Capuchin monkeys



Emotion: "Startle" as an excited amygdala screaming "flight or fight!"



Reason: Desired outcomes managed by the DLPFC recruiting resources for action



Solving the UA232 problem

'Pilots call such a state "deliberate calm," because staying calm in highpressure situations requires conscious effort. "Maintaining our composure was extremely challenging," Haynes says. "We knew we had to focus and think straight, but that's not always so easy." (Lehrer, 2013, p.125) **DLPC**: Dorsolateral Prefrontal Cortex, 'the rational centre of the brain'

<u>Reason</u> (DLPFC) What we think

Morality: Surprise as an occasion for learning managed by the error-monitoring ACC



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So "startle" is managed by the conversation between what we feel and what we think



So "startle" is managed by the conversation between what we feel and what we think



Framing

Framing the conversation between what we feel and what we think

The ACC lies at the intersection of two ways of thinking:

<u>What we feel:</u>	What we think:
Type 1 ('Fast') e.g., driving home	Type 2 ('Slow') e.g., learning to drive
Automatic, intuitive	Laboured, analytical
Reflexive, skilled	Deliberate, rule based
Heuristic	Normative
Associative	Deductive
Concrete	Abstract
Effortless	Costly

http://www.theguardian.com/books/2015/jul/18/daniel-kahneman-books-interview

Remember:

- -ve emotion is stronger than +ve emotion
- Emotion (System 1) is faster than Reason (System 2)

<u>Moral</u>:

- Get over aversion to losses! Think!
- You are up \$20 on your initial \$0
- Take reference points seriously!
- Faced with a decision, after being given \$50, to lose \$30 or keep \$20, which would you choose?
- The outcome is exactly the same, but most people would pick 'keep \$20'.



Losing \$30 is bad ☺ Keeping \$20 is good ☺ \$50 - \$30 = \$20 Losing \$30 is the same number as keeping \$20







Metacognitive exercises

Metacognitive exercise 1. Unconscious Bias

- Our automatic System 1 responses reveal unconscious bias.
 See the Stroop Test & the Thematic Association Test (TAT) Got it?
- How we treat others primarily requires fellow-feeling, not expertise. Gender stereotypes (particularly male's views on females) remain a barrier to diversity and inclusiveness in the workplace (particularly at senior levels) (Henderson, 2017)

A man witnesses his son in a terrible bicycle accident. He scoops up his boy, puts him in the back of his car, and races to the emergency room. As the boy is rolled into surgery, the surgeon says, "Oh, my God! It's my son!" How is this possible?



Metacognitive exercise 2. Bat and ball



- "Consider this little example, purloined from Kahneman's Nobel address...
- A bat and a ball cost \$1.10 in total.
- The bat costs \$1 more than the ball.
- How much does the ball cost?"
- Marc Wilson



Metacognitive exercise 2. Bat and ball



- "Consider this little example, purloined from Kahneman's Nobel address...
- A bat and a ball cost \$1.10 in total.
- The bat costs \$1 more than the ball.
- How much does the ball cost?" 10 cents, right?
- Marc Wilson

Metacognitive exercise 2. Bat and ball



"Consider this little example, purloined from Kahneman's Nobel address...

Got it?

- A bat and a ball cost \$1.10 in total.
- The bat costs \$1 more than the ball.
- How much does the ball cost?"
- Marc Wilson
- Let cost of bat = X
- Let cost of ball = Y

(X + Y = \$1.10)(X = \$1 + Y)(\$1 + Y) + Y = \$1.10)2*Y = 0.10Y = 0.05Cost of ball = 5 cents

Metacognitive exercise 3. David

David is 31 years old, single, outspoken and very bright. He majored in law and philosophy. As a student, he was deeply concerned with issues of the environment and social justice, and also participated in anti-nuclear demonstrations.

Which alternative is more probable (show of hands):

- 1. David is a lawyer; or
- 2. David is a lawyer and a member of GreenPeace?

http://www.theguardian.com/books/2015/jul/18/daniel-kahneman-books-interview

Mental toughness

The Big Four

Hansen: Navy Seals, Neuroscience, & Mental Toughness <u>https://vimeo.com/161547131</u>



 Goal setting (5:35): Break down goals to allow the mind to focus on one thing at a time without distraction.

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- Mental rehearsal/visualisation (6:27): So you're prepared for an event. Rehearse an if..then.. plan
- Positive self-talk (6:59): Use positive self-talk to motivate and persevere mental control
- Arousal (breath) control (7:45): Control mental state when aroused by outside stimuli to stay in command even in the most stressful circumstances

Summary



Metacognition and systematic error

- 'People make mistakes. More interestingly, people make a variety of systematic and predictable mistakes.' (Bazerman and Moore, 2006)
- Bloxham (2012) argues that, in medical Emergency Departments, failing System 1 behaviours often lead to treatment failure before System 2 behaviours kick in
- Sheffield, Margetts and Milward (2017) and Murray & Sheffield (2019) argue that training for bias awareness is cost effective.



Figure 1. Bias awareness, applied to NZDF and Health metacognitive programmes

Training Pilots for Unexpected Events – A Neuroscience Approach

- Ensure that individuals and crews practice a variety of unpredictable situations/scenarios in flight simulators (Casner et al, 2014, 2015; Landman et al, 2018)
- 2. Ground conceptual models for startle and surprise (e.g., Landman, 2017), framing, etc, in **neuroscience**
- Ensure individuals and crews are bias aware, and practice metacognitive monitoring and feedback skills (e.g., Kim, 2018) & deliberate switching of modalities)
- 4. Develop mental toughness via the **Big Four** techniques (e.g., like the US Navy Seals, but based on the dynamics of scenarios associated with stressful piloting events)

Most importantly,

Create a conversation between what we feel (e.g., Ralph Grunewald, GermanWings) and

what we know (e.g., Nancy Leveson, MIT) Wellington Cable Car (NZ)

Questions?

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