Background

Startle and surprise are often cited as potentially contributing factors to aircraft incidents due to their possible negative effects on flight crew performance. In the past, these terms have often been used interchangeably; however, there are distinctive conceptual, behavioural, and physiological differences between the startle reflex and the surprise emotion. The prevalence of startle and surprise on the flight deck has been investigated by examining voluntary incident reports in the Aviation Safety Reporting System (ASRS). Surprise has been found to be more prevalent than startle.

**Startle**

The startle reflex is the first response to a sudden, intense stimulus. It triggers an involuntary physiological reflex, such as blinking of the eyes, an increased heart rate and an increased tension of the muscles. The latter are necessary to prepare the body for the fight-flight response (Koch, 1999).

The startle response is accompanied by an emotional component which for a large part influences how a person responds to the unexpected event (Lang, Bradley, & Cuthbert,
The duration of the startle reflex, as with most reflexes, is very short and depends on the severity of the reflex.

A mild reflex lasts less than one second and a high-intensity response can last up to 1.5 seconds. Startle reflexes are more severe during very low or very high arousal levels. In addition to the involuntary physiological reflexes, startle inhibits the muscular activity, thus a startled person stops doing what he was doing (Koch, 1999). The disruption can last from 100ms to 3 seconds for simple tasks and up to 10 seconds for more complex motor tasks (Rivera et al, 2014).

On the flight deck the disruption caused by the startle reflex can have detrimental effects, particularly when the startle is elicited when the pilot is performing flight essential tasks. A pilot can lose part of the situational awareness, due to distraction which might cause cognitive tunneling. And pilots might be interrupted in a difficult cognitive process, such as making a decision (Rivera, et al, 2014).

**Surprise**

The psychology of surprise is about how people respond to unexpected events (Wickens, 2001). Surprise results from a disparity between a person’s expectations and what is actually perceived (Horstmann, 2006).

This implies that surprise can be elicited by the presence, but also by the absence of stimuli (e.g. Rivera et al. (2014); Bürki-Cohen (2010)). This contrasts with startle. Startle is always triggered by a sudden highly intensive stimulus and cannot be triggered by the absence of a stimulus.

The effects of surprise are in part comparable to those of startle. Physiological responses
to surprise include increased heart rate and blood pressure. Cognitive responses include confusion and loss of situational awareness. It may involve the inability to remember the current operating procedures (Rivera et al. (2014)).

Even though startle and surprise often occur together, the startle reflex can be triggered without the notion of surprise. For example under anticipated circumstances when a person is told that a loud noise will be audible and when, this person will usually still have a startle reflex resulting from the loud noise (Ekman, Friesen, & Simons, 1985). The duration of the surprise response is typically longer than that of the startle reflex. The discrepancy between expected and actual circumstances requires the person experiencing the surprise to reevaluate the situation to continue with the task. Larger discrepancies usually require more time for reevaluation than smaller discrepancies. Furthermore, the surprise also takes more time when the discrepancy requires an update of the expectations of the person experiencing the surprise (Horstmann, 2006).

The physiological response to surprise causes the attentional system to become more focused and impairs the working memory (Martin et al, 2012). The focus can help in evaluating the situation, especially when this is a dangerous situation in which you have to make choices quickly (Sapolsky, 1994).

However, people tend to focus on the most salient information, which may not be the most important information at that moment (Rivera et al, 2014). Also, the combination of focused attention with the impaired working memory can cause problems for the person experiencing the surprise regarding his main tasks.

EASA research project: Startle effect management
Dedicated to innovation in aerospace

Managing Startle & Surprise
PACDEFF 2016
Edzard Boland

A KLM and NLR project, commissioned by EASA


The Two Sides of Fear

Flight Operations & Training symposium
Montreal, 28-31 May 2018

AIRBUS
Airbus presentation on Startle “Two sides of Fear”.

mindFly human factor analysis

Targeted training could improve flight crew performance at the onset of in-flight emergencies, when pilots often are startled yet must rapidly make critical decisions with incomplete or confusing information.

Introduction of unexpected events and regular exposure of the crew to these events can reduce the impact of startle/surprise effect. Evidence based training can be used to develop realistic scenarios in training programme.