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Recovery from startle and surprise: A survey of airline pilots' operational experience using a startle and surprise management method

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ABSTRACT

A significant safety challenge airline pilots contend with is the possibility of experiencing startle and surprise. These are cognitive-emotional responses that may temporarily impair performance and that have contributed to multiple fatal loss of control events. Several self-management methods exist that are intended to facilitate recovery from startle and surprise, but these have only been tested in simulator experiments. The current study addresses this research gap by surveying the perceptions of 239 airline pilots on the utility and benefit of a method which they use in operational practice– the "Reset Method". Overall, the survey results revealed that pilots felt the method improved mental preparedness, and reduced stress. A reported reason for not applying the method was the urge to act quickly. In addition, not all steps of the method were applied equally, and some pilots found the method difficult to fit into the existing procedures of several time-critical scenarios (e.g., aircraft upsets and emergency landings). We recommend training self-management methods in scenarios which carry the most risk of negative effects of startle and surprise. We also recommend instilling awareness of the 'startle paradox': self-management techniques are most difficult to apply in situations where they are most beneficial. Method shortening and simplification may facilitate application. Future research should focus on refining the method's implementation, addressing the startle paradox, and understanding the transferability of startle and surprise management methods to other safety critical industries defined by complex sociotechnical interactions.

1. Introduction

The increased level of safety in aviation has created an "unconscious expectation of normalcy amongst pilots" (Martin et al., 2012). In the rare cases where things do go wrong, they often go wrong unexpectedly, and this can lead to the pilot experiencing startle and surprise (S&S). S&S reactions have been implicated as a contributing factor in several high-profile loss-of-control aviation accidents, such as Air France 447 in 2009 (BEA, 2012) and the Colgan Air accident (NTSB, 2010).

Startle is defined as a sudden involuntary reaction to an intense stimulus, such as a sudden loud noise (Rivera et al., 2014). The initial startle reflex occurs very fast, and is characterized by eye-lid closure, contraction of the face, neck and skeletal muscles, an increase in heart rate and arrest of ongoing behaviour (Koch, 1999). Attentional resources are directed towards the stimulus as a mechanism of threat appraisal (Martin et al., 2015). If the stimulus is perceived to be a real threat, the general stress response will remain, or even increase in intensity (Landman, 2019; Martin et al., 2015). An example of a startling situation in aviation is a lightning strike, which is accompanied by a loud bang.

Surprise is defined as "a cognitive-emotional response to something unexpected, which results from a mismatch between one's mental expectations and perceptions of one's environment" (Rivera et al., 2014). It is of longer duration than startle. If this mismatch cannot be resolved, a feeling of stress and loss of control of the situation can arise, leading to a loss of situational awareness and ultimately cognitive lockup (Landman, 2019). Attentional narrowing takes place (tunnel vision), as attention is focused on the maintenance and elaboration of the (incorrect) cognitive frame, instead of seeking out additional information to aid effective reframing (Klein et al., 2007). Surprises are common in aviation, but often inconsequential as the mismatch is usually resolved quickly (Kochan et al., 2005). Surprise in aviation often occurs in the presence of conflicting or ambiguous cues that impede successful

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reframing. For example, in situations where the automation does not function as expected (automation surprise) or where complicated failures occur without a clear cause.

Although startle or surprise may occur on their own, in aviation and other safety-critical domains they often occur together and are difficult to distinguish for the operator. The terms are therefore often used interchangeably in aviation (Rivera et al., 2014). When co-occurring, startle and surprise may have interacting detrimental effects on pilot performance (Casner et al., 2013; Landman et al., 2017a, 2017b; Kinney and O'Hare, 2020; Vine et al., 2015). Surprise induces cognitive demands, as sensemaking activities are required to make sense of the unexpected situation: a process known as "reframing" (Klein et al., 2007). Acute stress resulting from startle is known to disrupt cognitive processes that would be required for such sensemaking activities (Eysenck et al., 2007), resulting in an inefficient or unsuccessful reframing process. This may then lead to the following maladaptive behaviour:

- Attentional narrowing or and task shedding (Driskell and Salas, 2013; Stokes and Kite, 1994)
- Decision making becomes less systematic, more hurried, and fewer alternatives are considered (Dismukes et al., 2015).
- Team members coordinate less effectively and share less information (Dismukes et al., 2015).

Several approaches to mitigate startle and surprise impairments have been suggested. Some authors underline the importance of stress exposure (Driskell and Johnston, 1998) or using unpredictable and variable scenario simulator training (Landman et al., 2018). A second type of mitigation would be to teach pilots a S&S management method, such as "Breathe, Analyze, Decide: (Martin et al., 2016). A study funded by the European Union Aviation Safety Agency (EASA) led to the development of such a S&S management method (Field et al., 2018). It is differentiated from more extensive decision-making mnemonic aides such as FORDEC and DESIDE (Li et al., 2014) by being specifically aimed at managing the stress and confusion that could result from startle and surprise. Using breathing to control emotional responses and improve performance has been successfully used in other fields such as health care, military and law enforcement (Lauria et al., 2017). A second central aspect of the EASA-funded method is to consciously take a moment, to observe and take in the situation; a variation on the age-old wisdom of "sitting on your hands" (Field et al., 2018).

Further developments of this method have led to the implementation of a startle-management method in operational practice. In the current study, the application of this implemented method is evaluated (see Fig. 1; see also Boland, 2019). This method, from now on referred to as the "reset method" consists of five steps, which can be selectively used as desired:

1. Announce that a "reset" will take place.
2. Take physical distance (press back into the back of the seat, to prevent fixation on one cue).
3. Breathe: inhale, using abdominal breathing, and exhale slowly. Repeat if necessary.
4. Tense and relax shoulder and arm muscles.
5. Check the mental state of the fellow crewmember(s).

After completing the "reset", emphasis is placed on building situational awareness carefully and methodically (by calling out all observations before drawing conclusions). The airline that was the focus of this study introduced their own adaptation of the method in 2017. Pilots have been instructed to apply the method in situations where they considered it useful and necessary. The method was introduced with a briefing, after which pilots practiced the method in a classroom setting with a Virtual Reality headset (lightning strike) scenario, and then in a 3.5-h simulator session with several startling and surprising scenarios. An iBook explaining the theory behind the method using multi-media was distributed to pilots and instructors. The reset method is part of a more elaborate "Non-Normal Strategy (NNS)", which describes a suggested strategy for dealing with non-normal situations. The reset method is placed in the NNS after the first two steps: "protect yourself" (e.g. wearing an oxygen mask) and "flightpath under control". It is placed before calling out observations and identifying the failure, so as to avoid rushed, incorrect actions. After identifying the failure, memory items, checklists, possible troubleshooting and further decision making are addressed by the NNS.

Simulator evaluation of the precursor of the method within a major European airline (Field et al., 2018) revealed that it improved information collection (defined as calling out factual observations without giving opinions) and that pilots found the training useful. Research into similar methods is sparse. Landman et al. (2020) found decision-making in pilots was positively influenced by using a similar Calm down, Observe, Outline, Lead (COOL) method, stating the method would benefit from modifications to reduce complexity and reduce distraction. Research comparing the shorter Aviate, Breathe, Check (ABC) method to the COOL method showed a higher usefulness rating for the ABC method, confirming that brevity and simplicity may be important (Piras et al., 2023).

Anecdotal feedback from the EASA research showed that

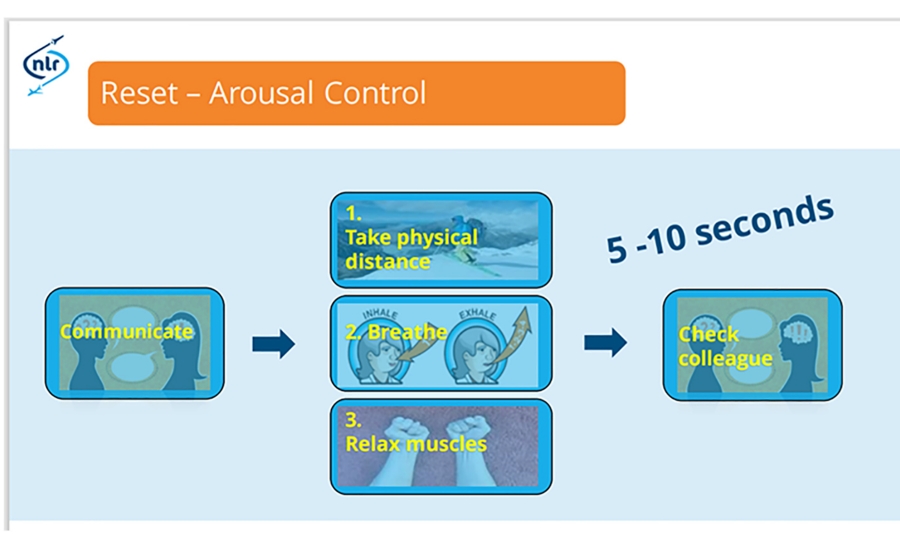

Fig. 1. The startle and surprise "reset" method. Picture obtained from Boland (2019).

participants often did not use the method in actual flight operations, even in cases where this would be appropriate (Field et al., 2018). To date no research has formally evaluated a startle and surprise management method in the operational environment. This is crucial, as the degree of startle and surprise can be much greater in actual operations compared to in the simulator (Field et al., 2018), which could cause pilots to forget to apply the reset method. Furthermore, previous simulator research suffers from the issue that pilots expect adverse events to occur in simulator settings, as opposed to the daily operation where things rarely go wrong (Comstock Jr et al., 2020) and might react differently. Pilots may use the method in the simulator just because it is expected by the instructor. Hence, research describing how pilots use a S&S management method provides insight into its value, and may provide directions for future adaptations to further optimize the method.

The present research was designed to address this current gap in knowledge, through a survey of pilots from a major European airline where the "reset" method has been in use for some time. The following three research objectives were established:

1. Assess the extent of application of the method among pilots in operational practice.
2. Determine the pilots' perceived usefulness of the method in real-life startle and surprise situations.
3. Identify pilots' reasons for not using the method.

2. Method

2.1. Survey development

To develop the content of the survey, ten semi-structured interviews with pilots, who served as subject-matter experts, were conducted. Using Braun and Clarke's (2006) thematic analysis, deductive coding of interview transcripts established the basis for the development of a suitably structured and worded electronic survey using JISC Online Surveys. Results of this analysis are published in (Vlaskamp et al., 2024).

The survey first assessed the demographic characteristics of the participants (rank, experience, aircraft type, instructor status and age range) and then addressed the three research objectives. To assess the extent of the application of the reset method among pilots in operational practice, participants were asked if 1) startle or surprise was ever experienced in actual flight operations (yes/no), 2) whether the reset method was used, and 3) which of the five elements of the method were used.

To determine the perceived usefulness of the method, all participants were asked to rate the degree in which they felt better or worse prepared for startle or surprise because of the reset method on a 4-point Likert-scale. In addition, specific benefits of the method were obtained from participants who had used the method in actual startle or surprise situations. They were asked to rate the method's perceived usefulness and its benefit on various factors: heart rate and stress level (representing, physiological responses to S&S, see Vine et al., 2015), confidence in handling the situation (self-efficacy, see Field et al., 2018) and problem-solving skills, decision-making skills, and situational awareness (competencies negatively impacted by S&S, according to Field et al., 2018). These factors were rated on a 5-point Likert scale.

A multi-response question was used to identify pilots' reported reasons for not using the method (e.g., method familiarity, startle or surprise recognition). Finally, to identify potential improvements to the method or its training, all participants were asked to rate the perceived ease of application and perceived usefulness of the method for eight different hypothetical situations: emergency descent, bird strike, automation surprise, upset, lightning strike, engine fire, rejected take off and failure without clear cause. The scenarios were chosen as they represent a variety of pure startle, combined startle and surprise and pure surprise events. Upset and emergency descent were based on input from the SME interviews (Vlaskamp et al., 2024). Two open questions provided opportunity for feedback on improving method training and modification. The scenarios were not further described. They are mostly well-trained and familiar to pilots. However, some variation in interpretation and operational experience in these events is to be expected.

2.2. Sample

A call for participation in the survey was published on the company news app, Microsoft's Viva Engage company communication app, a closed Facebook group and in an email newsletter. In total, 239 pilots responded out of approximately 3500 company pilots. All participants were active pilots of the investigated airline to ensure homogeneity in method training exposure. This research complied with the tenets of the Declaration of Helsinki and was approved by the Institutional Review Board at Coventry University (P147213). Informed consent was obtained from each participant.

2.3. Statistics

Data were analyzed using IBM SPSS™ 26. Logistic regression was used to evaluate the influence of demographic factors upon method application. Ratings on the scales were treated as ordinal and were compared between subjects using Mann-Whitney U tests or within subjects using Friedman tests, with post-hoc Wilcoxon signed-rank tests with Bonferroni correction. The percentage of pilots using different elements of the method and the barriers to use of the method were compared using A Cochran's Q-test, with a post-hoc Dunn-test. Spearman's correlation tests were used to analyze relationships between perceived difficulty of application and usefulness of the method in the eight hypothetical scenarios. For categorical responses Cochran's Q tests were used.

3. Results

3.1. Application of the reset method

Ninety-one percent of pilots (n=217) reported they had experienced startle or surprise. Of the 217 pilots that had experienced startle and/or surprise, 85 (39.2 %) reported having used the method, 132 pilots (60.8 %) had not. Table 1 presents a breakdown of method application by participant demographic. Use of the method ranged from 24.1 to 57.1 % across demographic categories. Largest deviations from the 39.2 % mean application rate included younger pilots (57.1 % application rate) and regional pilots (24.1 %). However, logistic regression analysis revealed that pilot demographics did not significantly predict the likelihood of method application, χ^2 (11) = 12.36, p = .337.

For those who experienced startle or surprise and had used the method, the percentage of cases in which specific method elements were used is shown in Table 2. There was a significant difference in the frequency the elements were used, $Q(4)$ = 58.39, p < .001. "Check colleague" and "deep breaths" were used by significantly more pilots than all other elements (p's < 0.001).

3.2. Perceived usefulness of the method

The perceived usefulness of the method for the participants who reported experiencing an actual startle or surprise event (n = 217) are presented in Fig. 2. Overall, 192 pilots (89 %) believed the method made them "a little" (57 %) or "a lot" (32 %) better prepared to cope with S&S events. In addition, compared to pilots who had not used the method in live operations, pilots who had used the method felt significantly more prepared for startle or surprise (Mdn =4), than those who had not used the method (Mdn = 3; U = 3498, p < .001, r=0.69).

Specific positive effects of the method, reported by pilots who used the method following a startle or surprise event (n = 85), are displayed in Fig. 3. There was a significant difference between reported positive

Table 1
Reported application of the method following startle or surprise ($n = 217$) by Demographic.

	Method Applied				
	Yes		No		TOTAL
TOTAL	85	(39.2 %)	132	(60.8 %)	217 (100 %)
RANK					
Cruise relief pilot	9	(50 %)	9	(50 %)	18 (8.3 %)
First officer	27	(35.1 %)	50	(64.9 %)	77 (35.5 %)
Captain	49	(40.2 %)	73	(59.8 %)	122 (56.2 %)
EXPERIENCE					
0–5000 h	20	(51.3 %)	19	(48.7 %)	39 (18 %)
5000-10,000 h	25	(32.5 %)	52	(67.5 %)	77 (35.5 %)
10,000+ hours	40	(39.6 %)	61	(60.4 %)	101 (46.5 %)
Instructor (TRI/E)					
No	51	(37.2 %)	86	(62.8 %)	137 (63.1 %)
Yes	34	(42.5 %)	46	(57.5 %)	80 (36.9 %)
TYPE					
Long Haul	41	(38.3 %)	66	(61.7 %)	107 (49.3 %)
Medium Haul	37	(45.7 %)	44	(54.3 %)	81 (37.3 %)
Short-Haul	7	(24.1 %)	22	(75.9 %)	29 (13.4 %)
AGE					
20–30	8	(57.1 %)	6	(42.9 %)	14 (6.5 %)
30–40	23	(35.9 %)	41	(64.1 %)	64 (29.5 %)
40–50	32	(40 %)	48	(60 %)	80 (36.9 %)
50+	22	(37.9 %)	36	(62.1 %)	58 (26.7 %)

Table 2
Reported use of the elements of the reset method ($n = 85$).

Element	N	%
Check colleague	60	70.6 %
Deep breath(s)	58	68.2 %
Relax muscles	34	40.0 %
Take physical distance	34	40.0 %
Announce reset	19	22.4 %

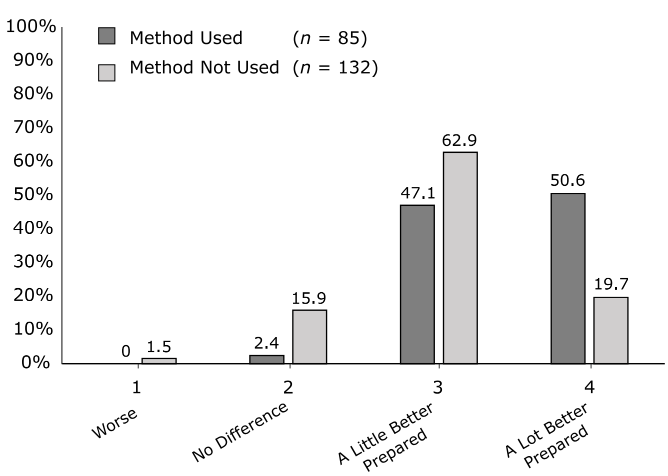

Fig. 2. Perceived change in preparedness for startle and/or surprise after introduction of the reset method ($n = 217$), comparing pilots who used and did not use the method.

effects, X^2 (5) = 26.22, $p < .001$. Post-hoc testing revealed that pilots reported a significantly larger improvement in perceived stress reduction, the largest reported improvement (*Mean* = 4.04, *Mdn* = 4, range: 2-

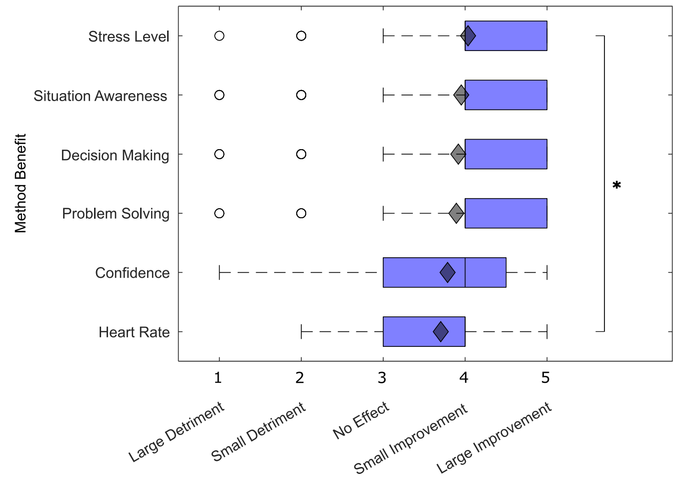

Fig. 3. Method benefits boxplots, reported by pilots who had used the method ($n = 85$). Means included as diamond symbols. Effects ranked in descending order according to mean effectiveness (*$p < .05$).

5), than in heart rate (*Mean* = 3.70, *Mdn* = 4, range: 1–5), the lowest reported improvement ($p = .015$, $r = -0.273$). Although the medians are the same for all measures, the significant difference reflects variations in the distribution of the rankings, which indicate higher perceived stress reduction. The method was believed to provide between 'small improvement' to 'no noticeable difference' across factors. Interestingly, several pilots reported negative experiences after using the reset method. This ranged from 3.6 % of pilots stating the method exacerbated (heart rate) symptoms, with between 9.2 % and 13.9 % of pilots reporting negative effects on the other factors. The participants who used the method were also asked to rate the method's usefulness (0 = negative effects, 1 = not useful, 2 = somewhat useful, 3 = moderately and 4 = very useful). None of the pilots reported negative effects here, and only 1 pilot answered "not useful". Seventy-one out of 85 pilots answered moderately or very useful.

Fig. 4 shows participants perceived situational usefulness of the method during eight hypothetical scenarios (unclear failure, rejected take off, engine fire, lightning strike, aircraft upset, automation surprise, bird strike and emergency descent). The perceived usefulness of the method for eight hypothetical scenarios was influenced by the type of scenario, X^2 (7) = 178.49, $p < .001$. Post-hoc comparisons revealed scenarios could be divided into 3 distinct groups ($p > .05$): lightning strike and unclear failure were the highest rated group (*Mdn* = 4, range:

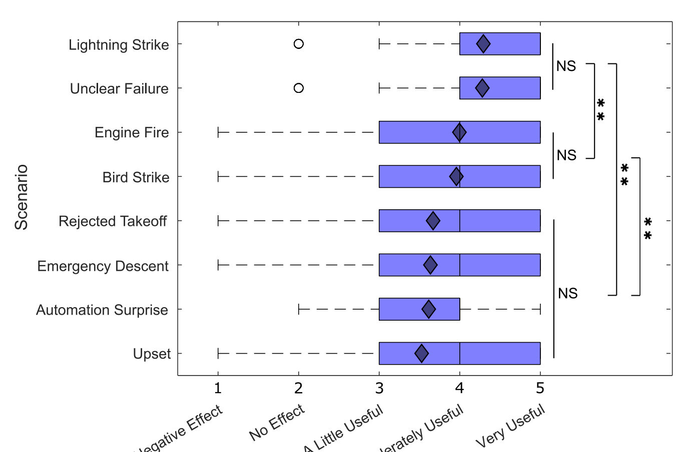

Fig. 4. Boxplots for the usefulness of the reset method in eight hypothetical scenarios ($n = 239$). Means included as diamond symbols. Scenarios ranked in descending order according to mean usefulness (**$p < .05$, ^{NS} $p > .05$).

3-5), followed by engine fire and bird strike (*Mdn* = 4, range: 1–5), whilst rejected takeoff, emergency descent, upset and automation surprise (*Mdn* = 3.75, range: 1–5) were judged to be scenarios were the method was least useful. Differences between these groups were significant ($p < .05$) with effect sizes ranging from $r=-0.16$ to -0.41.

In five of the hypothetical scenarios, several participants expected possible negative effects of using the method: engine fire (0.8 % of respondents), bird strike (0.8 %), rejected takeoff (6.3 %), upset (9.6 %) and emergency descent (7.9 %).

Participants judgement of the difficulty of applying the method in the hypothetical scenarios is presented in Fig. 5. Participants were given the opportunity to provide a null response ("don't know") if they felt they could not confidently provide a rating, requiring 38 (15.9 %) of cases to be removed via listwise deletion. According to Hair et al. (2018), listwise deletion is inappropriate when missing data constitutes over 10 % of the dataset. Consequently, missing data was handled using multiple imputation (Graham, 2009) using the full matrix of participants' responses to the difficulty of the eight hypothetical scenarios. The data met the 'missing completely at random' (MCAR) requirements for this approach (X^2 (61) = 56.74, p = .63) with 5 imputations being conducted for each scenario. Kruskal Wallis tests were conducted to ascertain the validity of the respective original scenario datasets against their corresponding 5 simulated iterations. No significant differences (p > .9) were observed between the original and simulated data on any of the 8 scenarios. Hence, the subsequent statistical analysis comparing differences between the 8 scenarios was based upon the pooled imputed datasets.

Upset was rated as the most difficult scenario to apply the method (*Mdn* = 4, range: 2-5), while a lightning strike scenario was rated as the easiest (*Mdn* = 2, range: 1–5). The perceived difficulty of applying the method differed significantly across the eight hypothetical scenarios, X^2 (7) = 606.47, $p < .001$). No difference ($p > .05$, corrected for number of tests) was found between engine fire, rejected takeoff, unclear failure and automation surprise. These constituted a 'mid-tier' group of scenarios with a combined median difficulty rating of 2 ('Easy'). All other pairwise comparisons were significant ($p < .05$) with effect sizes ranging from $r=-0.17$ to -0.57. High "impossible" application scores were found in the emergency descent (4.6 %), upset (10 %) and rejected take off (8.4 %).

For four scenarios, a significant negative correlation was found between the ratings for difficulty to apply and usefulness: rejected take off ($\rho = -0.51$, $p < .001$), upset ($\rho = -0.43$, $p < .001$), emergency descent (ρ = - 0.26, $p < .001$), and lightning strike (ρ = - 0.14, p=.036). For automation surprise, unclear failure, engine failure and bird strike, perceived usefulness was not significantly related to perceived difficulty to apply.

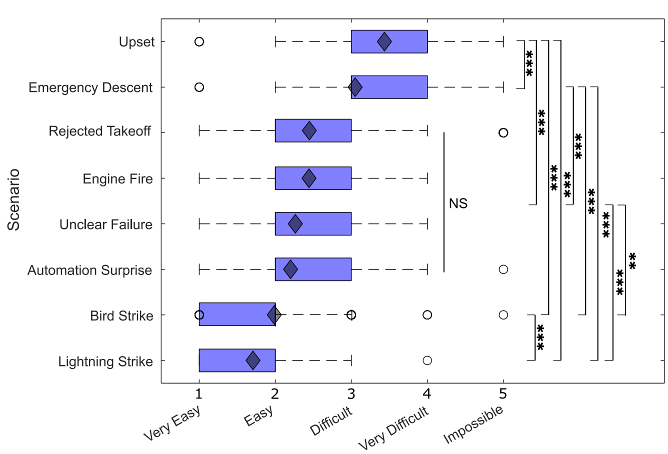

Fig. 5. Boxplots for the difficulty to apply the reset method in eight hypothetical scenarios (n = 239). Means included as diamond symbols. Scenarios ranked in descending order according to mean application difficulty (**$p < .01$, ***$p < .001$, ^{NS} $p > .05$).

3.3. Reasons for not using the reset method

Table 3 displays the reported reasons for not applying the method in the 132 pilots that experienced startle or surprise but did not use the method. There was significant difference in the reasons reported, $\chi^2(8)$ = 27.13, $p < .001$. "Being unfamiliar with the method" was the most prevalent reason, differing significantly from all other reported reasons, $p < .001$. The second most prevalent reason was "urgent action was required" which was reported significantly more often ($p < .001$) than "I forgot", "I didn't think it would help", "pressure from colleague" and "felt bad admitting that I was startled/surprised".

3.4. Free text comments

Several open questions were posed in the survey, to enable participants to expand on their answers and suggest improvements for training. The answers given underlined the feeling of having to act fast in emergency situations, such as the hypothetical scenarios ("no time to relax", "no time to apply such techniques" and "a reset would take too long" were typical answers given). Several participants indicated that at the time of the startle or surprise event they were unfamiliar with the "reset" method, as the recalled event predated the introduction of the reset method. Recognition of startle or surprise were reported to be difficult, especially detecting it in a fellow crew member. For training, pilots suggested to "… discuss situations how to use it when instant action is required" and encouraged sharing of positive experiences. Many respondents made positive comments about the method.

4. Discussion

Our survey revealed that a significant proportion of pilots (i.e., 39 %) used the "reset" S&S management method in operational practice, although nearly all pilots (i.e., 91 %) reported having experienced S&S. Most pilots (89 %) who had experienced S&S judged that being trained with the reset method would make them a little (57 %) to a lot (32 %) more prepared for S&S events. Those that had used the method reported experiencing several benefits, such as stress reduction and improved situational awareness and decision-making. These results align with results from simulator studies with similar S&S management methods, as these found improved decision-making, and positive evaluations by pilots (Landman et al., 2020; Field et al., 2018) as well. Pilots indicated that they felt better prepared for startle and surprise after the introduction of the method, with higher scores being given by those who had used the method since introduction. No demographic factors significantly influenced utilization of the method.

Whilst under half of the surveyed pilots had used the method in operational practice, only very few pilots (5 %) stated the method being

Table 3
Reasons for not using the reset method by the 132 participants that did not use the method in an actual startle or surprise situation (multiple responses could be selected).

Reasons for not using the method	N	%
Being unfamiliar with method	56	42.4 %
Urgent action was required	22	16.7 %
Other reason	20	15.2 %
I was not really that startled	16	12.1 %
No specific reason	15	11.4 %
Startle/surprise was not recognized	13	9.8 %
Forgotten	9	6.8 %
Method was not expected to be helpful	7	5.3 %
Felt bad admitting that I was startled/surprised	1	0.8 %
Pressure from colleague	1	0.8 %

unhelpful as the reason for not using the reset method. The most often reported reason for non-use (i.e., 42 %) was being unfamiliar with the method. The free text comments showed this was partly caused by participants recalling S&S events prior to the introduction of the method. Not all elements of the method were used equally. The urge to act fast, reported as one of the main reasons for not applying the method, likely played a role. The reported most-used element was “checking the well-being of one’s colleague” and the breathing technique. Preference for both techniques could stem from the fact that they are already widely employed, both in daily life and by individuals working in high stress environments, to ensure team coordination and to optimize stress and emotion regulation (Birdee et al., 2023; Fincham et al., 2023).

The least-used element was “announce reset”, followed by “take physical distance” and “tense/relax muscles”. Announcing “reset” was trained during the introduction of the method, but it is not currently described in the manuals of the company’s tested procedure, possibly explaining its underutilization. Several respondents remarked that they would prefer a shorter method, as they found it too “time consuming” and “hard to reproduce when caught off guard”. This is consistent with earlier research (Landman et al., 2020; Piras et al., 2023) in which the authors propose reducing complexity of their tested S&S management method. Considering the reset method, the “physical distance” and “tense muscles” steps could possibly be removed to increase brevity, so that three steps remain: announce reset, take deep breaths and check colleague. Apart from reducing the mental load, this could mitigate implementation barriers associated with the method’s perceived time-consuming nature. The high percentage for usage of the step “check colleague” shows that this step is considered valuable by pilots from a Crew Resource Management perspective. It is conceivable that this step prevents unnoticed incapacitation of the fellow pilot and increases crew situational awareness. Other methods, that are indeed shorter, do not include this step: e.g. COOL (Landman et al., 2020), ABC (Piras et al., 2023).

Pilots reported that applying the method would be difficult in certain hypothetical situations, particularly during upset recovery and emergency descent. In addition, perceived difficulty of application correlated negatively with the perceived usefulness for the method within half the scenarios. Upsets and emergency descent situations typically produce high degrees of startle (BFU, 2018; JTSB, 201; Martin et al., 2012), but also require immediate action. This likely is one of the reasons several pilots expect negative effects from using the method in these cases. Several real-life incident reports of incidents of decompression followed by an emergency descent show deficiencies in crew actions, likely caused by startle and surprise, such as those by the BFU (2018), KBSZTransportation Safety Bureau of Hungary (2011) and ATSB (2018), that describe “faulty decision making”, “actions taken too fast”, “not using appropriate checklist”. The BFU report quotes an incident airline’s training manual: “The most regular error made by crews is to rush this procedure”. These results show that pilots expect the method to be more difficult to apply in complex situations, as performing a full reset consisting of five steps would require allocating cognitive resources, in a situation with a high cognitive workload. Pilots would benefit from training on where to fit the reset into existing procedures. A reset after the initial upset recovery or immediate actions will better prepare pilots for a possible subsequent event and will improve situational awareness, leading to better decision-making (Landman et al., 2020).

The general positive evaluations of the method in our sample appear to conflict with the large proportion of pilots not using it when actually startled. An explanation of this could lie in the S&S effects themselves. Stress caused by S&S causes task shedding (Driskell and Salas, 2013) and a focus on threat-related stimuli (Eysenck et al., 2007), possibly explaining the strong urge to act to combat the threat and skip the reset method, as reported by pilots in the free text comments and interviews. Thus, there appears to be a “startle paradox”, namely that application of the method is more difficult in situations causing high startle, where it actually has the most operational advantage. Quick action can be counterproductive and can lead to incorrect intuitive decisions (Driskell and Salas, 2013; Field et al., 2018). Pilots generally prefer more problem-focused, emotionally avoidant coping strategies, normally useful for taking split-second decisions (Campbell and O’Connor, 2009). As the reset method is in essence an emotion-coping mechanism, its use may not come naturally to pilots. As one of the participants stated: “Pilots prefer fight over flight.” Further effects of the startle paradox likely include the named reasons for non-use: difficulty with recognizing the effects of startle and surprise, forgetting to use the method, and perceived pressure from the fellow crew member. The reported difficulty in recognizing S&S reinforces the importance of the step of checking the fellow crew member’s mental state. Explaining the startle paradox in training will possibly make pilots better able to recognize startle and surprise effects, keep an eye on the wellbeing of their colleague, and resist the tendency to act too quickly. Also, regular practice of performing the reset method in simulator settings could make it part of the pilots’ natural automatic responses to stressful events in operational practice.

Although none of the pilots experienced negative effects after having used the reset method, a small percentage of pilots (3.6 %–13.9 %) reported negative effects on specific factors, such as stress level, confidence, problem solving, decision making, situational awareness and heart rate. Pilots apparently experience some benefits of use, but not on all individual factors. Also, the method was not always used in its entirety, possibly influencing perceived effectiveness.

There are some limitations of the current study, that are relevant for interpreting the results. Of the survey sample, 34.7 % of the respondents were instructors, compared to about 20 % in the pilot population, reducing representativeness of our pilot sample. Although regression analysis did not indicate that application of the method was significantly affected by being an instructor, their views might have been more positive than those of the other participants. The survey measured perception and experiences of the method and are thus subjective, meaning that conclusions regarding actual effectiveness of the method based on these results should be made carefully. The reported impact of S&S can be distorted due to hindsight bias (Fischoff and Beyth, 1975) or fear of “losing face”. For many of the participants, the experienced S&S events will have taken place some time ago, reducing the accuracy of their memories of the event. These factors might have influenced the participants’ retrospective views of their handling of the situation and usefulness of the reset method. Martin (2013) showed in his simulator research that already after 20 min the startle perception of the participants was disturbed. Finally, the ratings regarding the hypothetical scenarios are, for most participants, not based on actual real-life experiences, but on their experiences in the simulator.

As the industry moves towards reduced-crew operations, individual operator performance becomes more critical and effective mitigation of startle and surprise becomes more important. Pilot application of S&S mitigation methods can possibly be supported by real-time monitoring of physiological S&S responses (Causse et al., 2017; Deniel et al., 2024; Schwerd and Schulte, 2020, 2021b, 2021a; Duchevet et al., 2024), especially when no colleague is present to monitor the pilot’s performance and provide emotional support. Future research could focus on the combination of S&S mitigation methods with real-time monitoring systems and application in reduced-crew operations.

5. Conclusion

Our survey indicates that the reset method was generally appreciated by pilots and applied in operational practice by a significant proportion. Pilot responses indicate that the method could be improved by simplification, and that pilots should be well-trained on how to fit the method into existing procedures, especially for complicated non-normal situations that combine high stress-levels and high workload with memory actions. Pilots should be made aware of the startle paradox in training, namely that they would likely have a strong urge to skip the method and act immediately, especially in the situations where the method would be most beneficial. Other safety-critical industries where human operators are an essential part of the system to ensure safety would likely benefit from this or similar S&S management methods.

CRediT authorship contribution statement

Daan Vlaskamp: Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Annemarie Landman:** Writing – review & editing, Validation, Supervision. **Jeroen van Rooij:** Writing – review & editing, Validation, Supervision. **James Blundell:** Writing – review & editing, Visualization, Supervision, Methodology, Formal analysis.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Authors Daan Vlaskamp and Jeroen van Rooij are employed at the airline that was the subject of this research. The remaining authors have no conflicts of interest to declare.

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Data availability

Data will be made available on request.

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