

The Impact of Wearing Facemasks on Pilot Non-Technical Skills During the COVID-19 Pandemic

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ABSTRACT

Masks on the flight deck are a part of an overarching biosecurity strategy intended to keep aircrew safe during the COVID-19 pandemic. The objective of this research was to explore pilot perception of the impact of mask wearing on non-technical skills. Four key non-technical skill areas were identified: communication, situational awareness, task management and decision making. Flight-crew perception on how mask wearing affects these skills was captured using a questionnaire. In addition, overall pilot attitude to mask wearing was captured concurrently. Sixty-two pilots with a variety of experience and backgrounds participated in the research. Analysis revealed communication to be a skill heavily impacted by facemasks. Results also align with the IATA risk assessment suggesting facemasks increase the time taken to don oxygen masks in the event of rapid depressurisation. The burden associated with flying whilst wearing masks also became evident. Flight-crew report increased feelings of fatigue when wearing masks, impacts upon crew resource management and performance. Overall, findings suggest that masks impact non-technical skills and subsequently crew resource management. These findings indicate that mask wearing might adversely affect flight safety. These findings should be considered when decisions are made to implement mask wearing in the cockpit.

KEYWORDS

Pandemic, aviation, communication, non-technical skills, safety

Introduction

Safety measures introduced during the Covid-19 pandemic have triggered widespread restructure of social systems including those within the aviation sector. This restructure includes modified flight crew interaction in civil aircraft cockpits that could impact safety and efficiency in the aviation system.

One safety measure recommended by The International Air Transport Association (IATA) includes the wearing of facemasks inflight by passengers *and* flight crew as part of a multi-layered approach to biosecurity (IATA, 2021a). The airline industry's biosecurity strategy is a collaborative plan in part coordinated by a policy framework established by overarching international regulation. The wearing of facemasks during flight is novel and modifies interactions in a safety critical environment. It is important that whilst maintaining biosecurity and passenger confidence, aircraft operators understand the impact of mask wearing on the flight deck and this is the focus of the current article. Specifically, this work is focused on the impact of mask wearing on non-technical skills (NOTECHS). NOTECHS are cognitive and social skills that characterise team performance (Yule & Smink, 2020). Crew Resource Management (CRM) is fundamental to flight safety and has been developed on the foundation of non-technical skills such as communication and decision making (Helmreich & Wilhelm, 1991). Thomas (2004) identified that NOTECHS are central to

CRM. It follows that changes in the efficacy of NOTECHS caused by facemasks could affect CRM. These effects on CRM could impact flight safety.

Most recently, Benitez et al. (2020) studied the impact of personal protective equipment (PPE) on surgeons NOTECHS during the COVID-19 pandemic. This study was centred on the premise of surgeons being required to wear *additional* PPE during the pandemic, including larger facemasks. The results showed 54 percent of surgeons reported communication issues. For example, responses indicated that the use of an N95 respirator degraded communication causing muffled voices and disrupted voice projection caused by face shields. Impaired vision was also reported as affecting situational awareness (Benitez et al. 2020). Finally, the study suggested that PPE use alongside adverse working conditions during the pandemic had increased biomechanical stress and fatigue, thereby impacting decision making. Moreover, Spitzer (2020) writing about the burden associated with masks in classrooms because of the pandemic, identified that occlusion of the lower half of the face negatively affects verbal and non-verbal communication. Spitzer highlighted that wearing masks interrupts facial processing vital to social cognition. This view is supported from the neurobiological perspective. Adolphs (1999) identified that social cognition is driven by facial recognition. Dynamic eye and mouth movements convey socially relevant information. Moreover, social cognition forms the basis of social behaviour. Occlusion of the face may disrupt social perception, cognition and behaviour cycles (Adolphs, 2001). Crucially, social interaction underpins NOTECHS (Flin et al., 2003).

In this article we build on the research by Benitez et al. (2020), moving the object of study into the aviation domain. We adopt the approach taken by Benitez et al. and develop a questionnaire that was distributed to airline pilots. The questionnaire asks flight crew about key impacts on core NOTECHS identified by Thomas (2004) that include communication, situation awareness, task management and decision making. These skills are complex and multi-faceted. Furthermore, the NOTECHS studied map onto the IATA competency framework (IATA, 2021b) that is used to develop evidence-based training programmes for pilots. The research addresses two aims:

1. How do flight crew perceive the impact of wearing masks on NOTECHS, communication, situation awareness, task management and decision making?
2. What are pilots' attitudes towards wearing masks in the cockpit?

Method

Design

To capture pilot views of mask-wearing on NOTECHS, a 46-item questionnaire was developed in conjunction with subject matter experts (SMEs). SMEs comprised senior airline pilots. Firstly, the questionnaire captured key demographic information relating to the sample. Then, items related to the key NOTECHS were identified. The overall NOTECH domains and number of items developed for each theme are shown in Table 1. Items associated with NOTECHS were measured using a five-point Likert scale capturing the extent of participant agreement with the item. As is typical with this type of scale, responses were numerically coded and treated as interval data for subsequent statistical analysis (Oppenheim (1992). Cronbach's alpha was also computed for each scale to support combining the questions into an overall score. Alpha co-efficients were high (> 0.80), indicating good agreement between items for each scale.

Finally, seven items asked participants about their attitudes to masks more generally from themes arising during discussion with the SMEs. A visual analogue scale was presented to participants to indicate their agreement with statements about mask wearing.

Analysis of the NOTECH data is at the scale-level giving four scores (communication, situation awareness, task management and decision making) for each participant included in the analysis. One-sample t-tests were conducted for each overall scale score and for each attitude question against a test score of three and 50 respectively. This test-score marks the centre point of the scale. Significant differences from three indicate that the score is significantly higher or lower than the ‘neither agree or disagree’ scale point across the group. A significant difference from three indicates that particular attention should be given to this NOTECH. The critical value for comparisons was Bonferroni corrected to control Type 1 error inflation across the multiple comparisons.

Table 1: The four major NOTECHS and their themes included in scale questions.

Communication	Situation Awareness	Task Management	Decision Making
(11 items, $\alpha = 0.96$)	(10 items, $\alpha = 0.95$)	(9 items, $\alpha = 0.96$)	(9 items $\alpha = 0.97$)
Content	Mental Workload	Pre-Flight Briefing	System Cue Evaluation
Relevance	Verify Information	Pre-Flight Planning	Assessment of Emergencies
Clarity (ATC & Crew)	Monitoring Systems	Verbalise Task Information	Understanding of Emergencies
Volume	Monitoring Crew	React to Change	Prediction of Event Sequence
Quality	Seek Information	Share Tasks	Contingency Planning
Quantity	Acquire Information	Prioritise Tasks	Risk Awareness
Workload	Visual Scan Patterns	Interrupting Cue Detection	Course of Action Selection
Closed Loop Communication	Intervention	Interrupting Cue Comprehension	Information Ambiguity
Understanding	Mental Models	Workload	Time Availability
Non-Verbal Communication	Crew Coordination	-	-

Materials and Procedure

The survey was designed and distributed using the Qualtrics survey platform. Links to the survey were made available using social media including LinkedIn and Instagram. The survey link was also shared on the open forum digest of the Institute of Ergonomics and Human Factors. The survey was open for four weeks from 7th May 2021 to 7th June 2021.

Results

Participants

Ethical approval for the study was given by Cranfield University Research Ethics Committee (CUREC). All participants were volunteers and gave informed consent to participate in the study. Sixty-two participants consented to taking part in the survey. Demographic details of participants are shown in Table 2.

Table 2: Descriptive statistics of sample demographics.

	N	Percentage of sample
Flight Hours		
0 – 1,499	11	17.7%
1,500 – 2,999	11	17.7%
3,000 – 9,999	26	41.9%
More than 10,000	14	22.6%
Rank		
Captain	31	50.0%
Senior First Officer	9	14.5%
First Officer	15	24.2%
Other	7	11.3%
Gender		
Male	53	85.5%
Female	8	12.9%
Non - Binary	1	1.6%
English First Language?		
Yes	42	67.7%
No	19	30.6%
Missing	1	1.6%

Participants represented the different facets of the wider flight community. The majority of respondents, 48.4%, reported flying predominantly short-haul operations, 14.5% as long haul and 21% as mixed and 16% as other. Fifty-eight percent of responses came from commercial airline pilots, 12.9% from helicopter operations, 9.7% from business jet operations, 4.8% from cargo airlines and 14.5% recorded as other. The other category included test pilots, manufacturer pilots, pilots with airworthiness backgrounds, police and air ambulance pilots.

Participants were also asked to report their experience of flying or training in a simulator while wearing a mask. Fifty percent of respondents reported experience of flying with masks. Of the 50% of respondents who had flown with masks, 67.7% reported that this was a mandated requirement, 25.8% reported that it was not and 6.5% preferred not to say.

During simulator training, 67.7% of respondents reported experience with a mask. Of these respondents, 85.7% reported wearing masks in a simulator as a mandatory requirement. 9.5% of respondents reported that it was not mandatory to wear masks in simulators and 4.8% preferred not to say.

Overall, 69.4% of respondents reported experience of either flying or training whilst wearing a mask. For the 30.6% of respondents with no experience of either flying or training whilst wearing a mask the survey was terminated and no further data was recorded. Exclusion of participants with no flying or simulator experience of wearing masks generated 43 cases for further analysis.

NOTECHS

Overall impact scores for each NOTECH group are shown in Figure 1. The communication NOTECH showed a significant difference from the test value of three and a large effect size ($t_{42} = 4.9$, $p < 0.001$, $d = 0.74$, two-tailed). No other NOTECHS were significantly different to the test value indicating a more limited perceived impact.

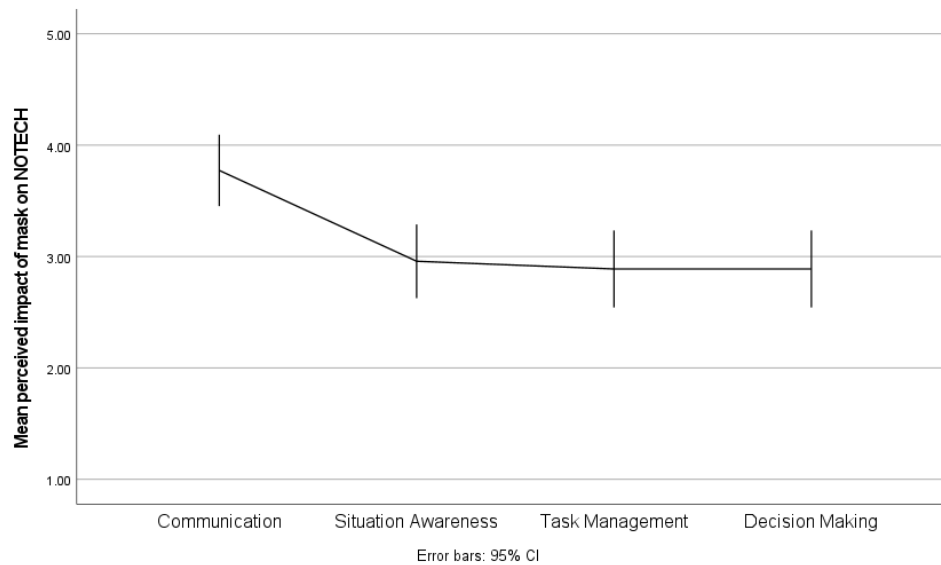


Figure 1 Mean perceived impact of mask on NOTECH. A higher score indicates higher negative impact. Error bars show 95% CIs.

In Table 3, we report comments made for each NOTECH group by participants that give context to the experience of flight crew while wearing masks in the cockpit environment.

Table 3: Comments made by participants on free-text questions.

Communication
<i>'Wearing a mask is fundamentally detrimental to communication'</i>
<i>'It is logical that facial expressions cannot be read in a dim lighted (sic), high workload environment'</i>
<i>'The times I have worn a mask in the simulator have completely degraded communication between crew'</i>
<i>'Communication – body language primarily does take a hit'</i>
<i>'At my previous employer, masks were mandatory until the moment cockpit door was closed'</i>
<i>'With the mic[rophone] properly adjusted we had no issues with comms'</i>
<i>'Communication with a good headset helps good understanding, even with a mask'</i>
Situation Awareness
<i>'Only issue is removing a mask in flight if visor / glasses fogging become an issue - so distraction'</i>
<i>'Smoke [misting] on sunglasses is one of the most important drawbacks of wearing a mask'</i>
<i>'As I wear glasses for flying which steam up when wearing a mask, it makes things almost impossible'</i>
<i>'With glasses, they fog, hence troubles scanning'</i>
<i>'Break down of non-verbal communication, reduces situational awareness in a multicrew cockpit'</i>
<i>'Again, huge degradation of situational awareness wearing mask ...'</i>
Task Management
<i>'Worse when communicating with cabin crew'</i>
<i>'CONSTANT distraction'</i>
Decision Making
<i>'Discussions are clearly more difficult'</i>

*'Added complexity with glasses on, misting of the lenses, hot sweaty discomfort'***Attitudes**

Figure 2 shows results from the seven items that captured attitudes about flight crew wearing masks. The questions themselves were positively framed (e.g., “Masks do not increase my feelings of fatigue”). However, for clarity of interpretation the graph shows agreement with a negative statement rather than disagreement with a positive statement. All t-tests report a single sample comparison between 50 and the mean score for the category. All tests are two-tailed.

Overall participants reported that masks were inconvenient when eating or drinking ($t_{39} = 7.8$, $p < 0.001$, $d = 1.23$), masks will increase the time to don oxygen masks ($t_{39} = 6.7$, $p < 0.001$, $d = 1.10$), masks increase feelings of fatigue ($t_{39} = 3.0$, $p < 0.01$, $d = 0.47$) and masks affect CRM ($t_{39} = 2.5$, $p < 0.02$, $d = 0.40$). The comparison for ‘Masks affect crew performance’ approached significance ($t_{39} = 1.62$, $p = 0.11$, $d = 0.26$). This variation is likely due to the variety of meanings of performance to participants. Other comparisons were not significant.

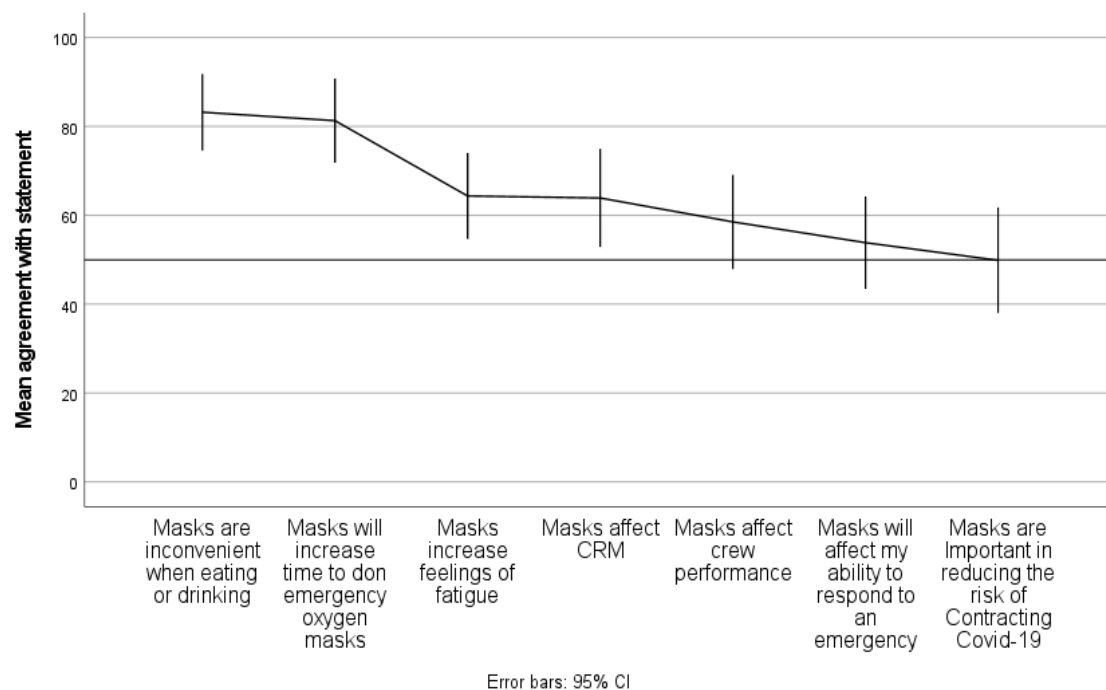


Figure 2: General perception of mask wearing on the flight deck. A higher score indicates a higher negative impact of mask wearing. Themes are ordered by effect size; error bars show 95% CIs.

Discussion

This article set out to capture the impact of facemask wearing on NOTECHS from the perspective of flight crew. In addition, the research aimed to gain an understanding of flight crew attitudes towards wearing masks in the cockpit more generally. An overview of impacts is shown in Figure 3. The results of this research could be used by airlines to make informed policy decisions as the aviation industry continues to operate during the pandemic, or to form the basis of a wider discussion about the issues with flight crew.



Figure 3: Depiction of impact of mask wearing on NOTECHS. Red indicates higher impact, amber indicates a moderate impact and green indicates lower impact as reported by flight crew.

Results reveal communication is predominantly impacted by mask wearing. Findings align with the theoretical literature which identified that occlusion of the lower half of the face reduced both verbal and non-verbal communication (Spitzer, 2020). Moreover, the results demonstrated that impact to communication subsequently impacts elements of both SA and task management. This view is supported by Flin et al. (2003) who stated that communication is a mediator of all non-technical skills.

Results also indicate that crew coordination is impacted by the wearing of facemasks by flight crew. Crew coordination is central to CRM and its effectiveness is critical to flight safety, (Helmreich, 1984). The causal links between facemasks, impacted communication and crew coordination illustrates the potential for masks to reduce flight safety margins. The elements of task management highest impacted were pre-flight briefing and verbalisation of task information, once again two elements predicated on effective communication. Wickens and Alexander (2009) allude to the connection between task management breakdowns and reduction in flight safety. Impacted communication that in turn affects elements of task management could have a negative effect on flight safety. Facemasks may well have the unintended consequence of disrupted cockpit management and subsequent reduced safety margins.

One limitation of this work lies in the dynamic nature of the pandemic. Biosecurity praxis varies between airlines and international borders and may shift along with the constantly developing pandemic. Scope of the research was narrowed to flight crew operating whilst wearing masks during the pandemic. Consequently, the research cannot reflect international variance or wider influences. Nonetheless, the results of this study carry value to airlines across the world who are operating aircraft during the global pandemic. Another limitation is the subjective nature of the data. Naturally, the perceptions of flight crew are important when investigating the issue however, these perceptions may be biased due to broader issues with acceptance of facemasks by individuals. Any comprehensive analysis would need to take into account cockpit behaviour in addition to perception. Observations could be included as part of line operations safety assessments (LOSA) style activities conducted by many airlines in one form or another.

Feedback from the people who have flown aircraft during the pandemic while wearing facemasks indicates that this biosecurity measure can adversely affect flight crew interaction. Results suggest that these effects on crew interaction could negatively impact NOTECHS, reducing CRM efficacy and ultimately present risks to flight safety. In the early stages of the pandemic when little was known about the virus, incorporating mask wearing for flight crew as part of an overarching biosecurity strategy signalled resilience. As our knowledge of Covid-19 evolves, it may now be the

time to take another look at flight crew facemask policy during operations as airlines continue to navigate the COVID-19 pandemic.

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