An exploratory focus group study of factors influencing helicopter pilots' Non-Technical Skills

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ABSTRACT

Non-technical skills are the interpersonal and cognitive skills that promote effective performance alongside a pra2ctitioner's technical abilities in their working environment. Whilst helicopter pilots are trained and assessed in non-technical skills, there is a lack of encompassing research assessing the factors which influence these skills as a whole. The current study aimed to report and compare factors which influenced the utilisation of non-technical skills across two pilot groups; search and rescue and offshore transport. Fifteen semi-structured focus group sessions were undertaken (n=8offshore transport, n=7 search and rescue) where pilots were asked a series of open-ended questions centred around factors that influenced their non-technical skill utilisation. Focus group analysis was conducted by way of inductive thematic analysis to identify and compare factors. Workload, stress, individual influences, crew interaction/composition, environmental influences, changes and the status of other non-technical skills were identified as overarching factors which influenced the utilisation of pilots' non-technical skills. Each factor consisted of a range of specific elements. While there was no variation between pilots on a factor level (e.g. workload), there was significant variation on the elemental level (e.g. too high a workload for offshore transport vs. not having all relevant mission information for search and rescue). The results indicate that while there are similarities in the overarching factors that affect non-technical skill utilisation, variations exist on the elemental level. Non-technical skills training, therefore, should be adapted for specific mission types and focused around role specific elements.

KEYWORDS

Non-technical skills, safety, search and rescue

Introduction

The world of rotorcraft aviation has, as with its fixed-wing counterpart, experienced a collection of accidents related to human error in recent years. Whilst the majority of helicopter flights experience safe outcomes (e.g. of 165,200 UK offshore, onshore and emergency helicopter flights in 2016, only 3 resulted in a serious incident/accident (CAA, 2017)), incidences of human error still highlight the need for a focus on the skills that promote flight safety. One such incident, in 2013, occurred when a Super Puma helicopter crashed into the sea on approach to Sumburgh Airport in the Shetland Islands, killing four passengers. The resulting investigation identified lapses in

situation awareness and decision-making as primary contributors towards the accident (AAIB, 2016). Indeed, the Sumburgh crash is not stand alone in this regard, with an estimated 70-80% of aviation accidents implicating human error over technical fault (Shappel & Weigmann,1996). With the recognition that human error plays a significant role in adverse incidents, the aviation industry has placed increasing focus upon the development of Crew Resource Management (CRM) training over the last four decades centred around the non-technical skills of pilots and crews (Helmreich, Merritt, & Wilhelm, 1999).

Non-technical skills

Non-technical skills (NTS) are the interpersonal (leadership, communication, teamwork) and cognitive (situation awareness, decision-making, task management) skills that complement a practitioners' pre-existing technical capabilities within their working environment (Flin, O'Connor, & Crichton, 2008). These skills have been investigated in a host of high-risk industries ranging from nuclear industry (Crichton & Flin, 2004) to agriculture (Irwin & Poots, 2015).

Current CRM regulations for helicopter operators

The European Aviation Safety Agency (EASA) states that before operating an aircraft, the crew member/s should receive CRM training appropriate to their role as specified in the operator's operations manual and that modular CRM training should be distributed over three-year cycles. This training should be conducted in a "group session away from the pressures of the usual working environment so that the opportunity is provided for flight crew members to interact and communicate" and should be conducted by a suitably qualified CRM trainer. Additionally, EASA specifies that CRM training should be integrated into operator (aircraft type) conversion courses (EASA, 2013 p. 87). The Civil Aviation Authority (CAA), as guided by EASA, stipulate that training in NTS required for the issue and maintenance of a valid licence and additional training and testing is required before a pilot can operate in a multi-crew environment (CAA, 2016). Specifically, EASA recommends NOTECHS, a behavioural taxonomy developed in fixed-wing aviation, for use in the assessment of NTS (EASA, 2016).

Differences between pilot groups

While NTS research has its roots embedded in the aviation industry's development of CRM, there is surprisingly little encompassing research categorising or assessing NTS as a whole in relation to helicopter pilots; or indeed explore differences between helicopter pilots as a function of their role. What research there is, predominantly based upon military pilots, focuses on evaluating CRM's effectiveness on the utilisation of specific NTS (such as teamwork, communication or assertiveness (Salas, Fowlkes, Stout et al, 1999; Leedom & Simon, 1995)) and not NTS as embedded within a taxonomy-based, helicopter-specific, framework.

Rotorcraft and fixed-wing pilots carry out different tasks and have distinct capabilities based upon the aircraft they utilise. Helicopters require significantly less ground infrastructure than fixed-wing aircraft and are able to fly at lower altitudes, accessing remote locations that fixed-wing aircraft cannot (Morrowsky & Funk, 2016). Helicopters, therefore, are ideal for roles such as search and rescue, medical evacuation and offshore transport. Research has detailed differences in fixed-wing pilot skillsets dependant on the mission type (Helmreich, Wilhelm, Gregorich, & Chidester, 1990). The same could be argued for helicopter pilots who operate a range of services with differing crew sizes and travel distances, in helicopters with different specifications – all of which have been implicated in having an impact on helicopter pilots' skills such as communication and decisionmaking styles (Morrowsky & Funk, 2016). A recent interview study of offshore transport and search and rescue pilots found that both pilot groups utilised the same key NTS reported in other domains of high-risk, however, these skills were utilised differently and made up of varying behavioural elements based upon flight mission parameters. Additionally, the authors reported a new skill category of 'cognitive readiness' which encapsulated the range of dynamic response behaviours exhibited by search and rescue pilots (Hamlet, Irwin, & McGregor, 2018).

Previous research has made progress in identifying the factors which impact NTS in various highrisk industries. Sasou and Reason (1999) identified various workload related factors which contributed towards team and individual-based human errors in aviation, shipping, and nuclear industry. Endsley (1995a, 1995b) too has described multiple factors which could impact the NTS of situation awareness, including distraction, high task load, and memory failures, and how their effect on situation awareness could adversely impact decision-making. Research looking at medical teams has described how closed-loop communication and mutual respect facilitate effective teamwork (Weller, Boyd, & Cumin, 2014) whereas conflict has been identified as a contributor to potential breakdowns in teamwork within aviation (Flin, O'Connor', & Crichton, 2008). With the apparent variability between helicopter pilot groups, distinct from fixed-wing aviation, one could expect similar differences in the factors that influence their NTS. Therefore, it is highly important for research to identify role-specific factors which influence the utilisation of helicopter pilots' skills so that NTS training may be better tailored to specific mission types and error mitigation strategies may become increasingly robust.

The current study

With a notably high proportion of aviation accidents implicating human error, it is of critical importance to further research exploring NTS and the factors which influence their utilisation. While research investigating individual NTS has been conducted within aviation, though arguably to a much greater extent within the fixed-wing domain, there has been, thus far, no exploratory studies looking at factors which influence NTS grounded within a helicopter-specific framework. Therefore, the research aim of the current study is to identify these factors by way of role-specific focus group sessions and to assess any differences between the two distinct samples of offshore transport and search and rescue pilots, in alignment with the sample of Hamlet, Irwin, and McGregor (2018).

Method

Design

Focus groups are a commonly used methodology in qualitative exploratory research (Barbour, 2007). Sessions involve the facilitation of discussion between members of a group in order to produce meaningful data (Kitzinger, 1995). These group sessions are overseen by a researcher and are typically audio recorded (Gill, Stewart, Treasure, & Chadwick, 2008). The current focus group sessions were designed to promote the consideration of factors which influenced the pilots NTS. Previous analysis of focus group methodology found that 80% of themes are identified within two to three focus groups and 90% are identified within three to six (Guest, Namey, & McKenna, 2016). Based upon this and the principles of data saturation outlined by Francis et al. (2010), a minimum starting criterion of six focus groups per sample was implemented, with additional focus groups being incorporated for both samples in order to include additional helicopter operators. Data

saturation, the point at which no new themes are identified, was reached within the original six focus groups.

Ethics Approval

This study was approved by the University of Aberdeen, School of Psychology ethics committee, Scotland (November 2017).

Participants

Two helicopter pilot groups (offshore transport and search and rescue) were recruited from three helicopter operators (two UK based, one Canadian). While all offshore transport focus groups were conducted face-to-face in an office environment (n=8), search and rescue focus groups (n=7), due to base locations, were conducted over the phone. Offshore transport pilots ranged from 27-59 years of age and spanned in experience from 3.5-40 years. One offshore transport participant was female. Search and rescue pilots ranged from 37-55 years of age and spanned in experience from 12-36 years. All search and rescue pilots were male. Focus groups consisted of groups of three pilots (n=3 offshore transport) and two pilots (n=5 offshore transport, n=7 search and rescue).

Data collection

Before focus groups were conducted, an invitation email was sent to all participants either from the researcher or from an internal contact within the organisation. Focus groups were audio-recorded and lasted approximately one hour. Data collection took place from December 2017 – July 2018, in either an office at the operators' headquarters or over the phone from the University of Aberdeen. All focus groups were transcribed verbatim by the researcher and two assistant researchers.

Participants were first briefed and then were asked to sign a consent form or confirm their consent verbally and demographic information was collected. Participants were then asked to discuss the factors which influenced their utilisation of NTS and overall performance. Where conversation was not upheld the researcher would attempt to probe for additional information or positive factors, as negative factors were predominantly mentioned. The researcher would finally ask about two key factors identified in background literature; fatigue and stress.

After the focus groups were concluded, participants were verbally debriefed and given a debriefing form with the contact details of the researchers and points of contact within their organisation.

Thematic data analysis

Inductive thematic analysis was utilised to code the data; guided by the procedures outlined by Braun and Clarke (2006; 2013). Data was first collected and read through by the researcher before initial themes and elements were constructed on an iterative basis. Inductive thematic analysis, as detailed by Patton (1990), involves the bottom-up process of allowing observations from data to inform the creation of themes. Inductive thematic analysis, therefore, is not based upon a pre-existing theoretical framework and was considered to meet the exploratory needs of the research objectives. While there is indeed a backdrop of literature surrounding factors influencing various NTS in fixed-wing aviation, it was essential to leave room for additional factors with no theoretical basis to be characterised.

Results

Inductive thematic analyses of search and rescue and offshore transport pilot focus groups identified the same overarching factors that influenced their utilisations of NTS. Whilst these factors proved to be the same for both pilot groups, they varied on an elemental level. Factors and shared and individual elements can be viewed in Table 1.

Table 1. Shared and role-specific factors influencing NTS utilisation in offshore transport and search and rescue pilots with frequency by which factors were discussed in focus groups. ¹Shared element, ² Offshore transport specific element, ³Search and rescue specific element

Factor	Elements	N (of 15 for shared factors, of 8
		for offshore specific, of 7 for
		search and rescue)
Workload	Task saturation ¹	3
	Too high a workload ²	2
	Not having all relevant information ³	1
	Use of technology ³	1
	Following SOPs ³	2
Stress	Job related ¹	9
	Home related ¹	10
	Positive impact of stress ¹	2
State of other skills	Communication ¹	7
	Teamwork ¹	4
	Leadership ¹	2
	Training ¹	4
	Situation Awareness ³	2
Individual influences	Illness ¹	5
	Fatigue ¹	13
	Loss of attention / distraction ¹	5
	Mood/attitude ¹	3
	Nutrition ³	1
	Physical fitness ³	1
	Experience ³	1
Crew interaction /	Current state of other crew member/s ¹	4
composition	Personality of other crew member/s ¹	5
•	Compatibility with other crew member/s ¹	4
	Conflict ¹	3
	Familiarity with other crew member/s ³	3
Environmental factors	Weather ¹	2
	Aircraft type / ergonomics ¹	4
	Noise ¹	2
	Vibration ¹	2
	Company culture ²	2
	Flight gear ²	1
Changes	Unexpected changes to task ¹	3
-	Technical malfunction ¹	3
	Changes to equipment ³	1

Workload

Pilots from both groups referred to a range of workload related factors that influenced their utilisation of NTS. Task saturation, the increase of immediate tasks to address in the cockpit, was shared between both groups.

"Communication is affected by the fact we have so many radios on board... you'll have four people talking on different radios at once" – [SAR Group 1]

Offshore transport pilots referred specifically to the impact of having too high a workload upon their NTS. Search and rescue pilots highlighted how not having all the relevant information on a task adversely affected skills such as situation awareness, but this could be addressed by using technology on-board the aircraft (e.g. radios, advanced camera equipment). Additionally, search and rescue pilots mentioned how following standard operating procedures (SOPs) helped improve the use of their NTS.

Stress

For both pilot groups stress was a frequently mentioned factor. Both reported the presence of workrelated stress (e.g. redundancies) and home-related stress (e.g. fighting with a partner) and how they impacted NTS on the job.

"We have all been on the chopping block at some point. That feeds into how we perform out on a flight... that can sort of increase your stress levels" [OT Group 1]

Additionally, both groups mentioned that stress could often be a beneficial factor suggesting that at an optimal level of stress could be a motivator and increase performance, whereas too little stress could lead to under-arousal.

State of other skills

Both groups reported the impact that various NTS had on each other. Most commonly brought up were communication, teamwork and leadership and the knock-on effects that lapses in these skills presented.

"Good communication, it makes things so much easier, it makes decision-making...teamwork... coming up with the plan easier" – [SAR Group 3]

Search and rescue specifically referred to how situation awareness lapses impacted on other skills. Both reported training helped them to better utilise their NTS.

Individual influences

Both pilot groups reported a host of individual influences that impacted NTS utilisation including illness, loss of attention/distraction, their current mood/attitude and critically fatigue (mentioned most often).

"I've been fatigued... I realised I shouldn't have been flying" – [OT Group 4] Search and rescue pilots specifically referred to the impacts of nutrition and physical fitness.

Crew interaction / composition

Crew interaction was a significant factor mentioned by both pilot groups. For both the current state (mood) and personality of the other crew member were reported as well as their overall compatibility with other crew members.

"P1: Yeah so personality clashes is a big one because you... stop listening.

P2: You do detune them... so communication is broken down"- [OT Group 5] Both groups also noted how conflict with other crew members could adversely impact NTS. Search

and rescue alone discussed the pros and cons of being familiar with their other crew members.

Environmental factors

A range of environmental factors was reported by both groups including weather, aircraft type/ergonomics, noise, and vibration. Offshore transport pilots also mentioned how flight gear could cause discomfort and distract them.

"The survival suits and the life jackets. They're always a distraction to be able to communicate, make decisions and have teamwork" – [OT Group 3]

Offshore transport pilots also highlighted how the culture of the organisation could influence the way they undertook their roles and as a consequence their NTS.

Changes

Both pilot groups reported how changes impacted their NTS. Shared elements included unexpected changes to task and technical malfunctions with the aircraft. Search and rescue pilots discussed how changes to their usual equipment also negatively impacted NTS.

"Equipment available can have a huge effect on what you're able or capable of doing and the decisions you make" – [SAR Group 2]

Discussion

Inductive thematic analysis identified seven primary factors that influenced pilot NTS: workload, stress, the state of other skills, individual influences, crew interaction/composition, environmental factors, and changes. Each factor was broken down into specific elements, some of which were shared, others were role specific.

The identification of workload as a factor influencing helicopter pilots' NTS adds support to previous work detailing workload management as an important feature of maintaining safety in industries such as rail work (Rail Safety and Standards Board (RSSB), 2016) and fixed-wing aviation (Sexton & Helmreich, 2000). Specific elements, such as the discussion of too high a workload by offshore transport focus groups may be a factor of the current state of the industry. Indeed offshore transport pilots reported pressure to take on a higher workload for job security. Search and rescue pilots reported that not having all relevant information impacted their situation awareness; as was previously reported by Endlsey (1995a). However they also discussed how using technologies available to them (e.g. real-time weather updates, advanced camera equipment) helped them acquire more detailed task-relevant information, thereby reducing their workloads. Both pilot groups reported that task saturation, a build-up of immediate tasks and limited time/resources to address them, impacted their use of NTS. This effect has previously been reported as a factor leading toward pilot error (Endsley, 1999).

Similarly, the factor of stress has a detailed backdrop of literature outlining its negative impacts on pilot performance. Alkov, Gaynor, and Borowsky (1985), in an analysis of pilots involved in major aircraft accidents, found that pilots that had ineffective life-stress comping mechanisms also demonstrated breakdowns in teamwork behaviours. In the current study stress was broken down into two elements; home-related and job-related. Previous research has implicated home-related stress (e.g. spousal stress), as a chronic stressor for pilots (Fielder, Rocco, Schroeder, & Nguyen,

2000; Karlins, Koh, & McCully, 1989). Similarly, research has found that pilots working for corporately unstable operators experienced higher work-related stress and in turn, depressive symptoms (Little et al., 1990). Both pilot groups referred to an optimal level of stress whereby performance was in fact increased. This attitude is reflected in the 'Yerkes-Dodson Law', which hypothesised that a degree of stress/arousal promotes effective performance (Cohen, 2011).

The finding that the state of a skill could impact the effectiveness of another adds support to various researches describing the inter-dependence of such skills. For example, Endsley (1995b), described how the state of situation awareness could impact the effectiveness of flight decisions, and Michan and Rodgers (2000) described how the NTS of teamwork was affected by skills such as communication, leadership, and decision-making amongst others.

Of all individual influences reported, fatigue was the most prominent with nearly all pilot groups reporting it as a primary contributor to the breakdown of their NTS. Pilots frequently associated increased stress with heightened fatigue, indeed previous literature has linked the effect of the two as having a detrimental impact on situation awareness in oil and gas industry and agriculture (Sneddon, Mearns, & Flin, 2013; Irwin & Poots, 2015). Loss of attention/distraction was also reported to have an impact on NTS by pilots and has been detailed as a primary contributor to situation awareness errors (Endsley, 1995a). Factors such nutrition (i.e. hunger), reported by search and rescue, and illness, reported by both pilot groups, have previously been categorised as 'personal factors' by Wetzel et al. (2006) who considered them stressors that impacted surgeons' performance. Additionally, previous research has demonstrated that being in an emotional mood state can increase rates of distraction (Seibert & Ellis, 1991). Indeed, anger specifically can be linked to a host of influences upon judgement, attention, decision-making and risk perception (Lerner & Tiedens, 2006).

Discussions of the mood of the individual often preceded an expanded conversation of crew interaction/composition factors. Most commonly reported were the personality traits of other crew members, previously found to have an impact on both individual and crew performances in flight (Chidester, Helmreich, Gregorich, & Geis, 1991). In addition to this, the current state (i.e. mood) of other crew members was discussed as well as compatibility between crew members. Conflict was also reported as having a detrimental effect on NTS, indeed Flin, O'Connor, and Crichton (2008) suggest that conflict can lead to poor team performance and even in extreme cases the complete division of a team unit. Uniquely search and rescue pilots referred to familiarity both positively and negatively in regards to crew composition. Search and rescue operators typically have smaller rosters and operate on longer day/night shifts from a SAR base, forcing crew members to operate together more often and spend considerably more time together than offshore transport pilots. This was could allow for more familiarity with crew members abilities and skills, or, inversely, for the identification of personality types/incompatibilities between crew members.

A range of factors relating to the environment pilots work in, such as weather conditions, aircraft type, noise and vibration were reported by both pilot groups. Weather conditions have been reported to have an adverse impact on situation awareness (Endsley, 1995a) and have been linked to pilot error (Li, Baker, Grabowski, & Rebok, 2001) so it should come as no surprise that both pilot groups highlighted its impact. Of interest was the finding that noise and vibration would impact NTS and induce stress and fatigue like effects. Studies have linked noise stress to hearing damage in workers (Mackie, O'Hanlon, & McCauley, 1974), and many pilots from both groups reporting hearing suffering from tinnitus which has been found to have an impact on attention-based tasks

(Hallam, & Jake, Hinchcliffe, 1988). However, research has struggled to establish a link between the elements of noise and vibration when presented together, as they would in a helicopter cockpit, upon cognitive performance or stress (Ljungberg, Neely, & Lundström, 2004; Ljungberg & Neely, 2007).

Finally, the category of changes encompassed elements that were often unforeseen to pilots, such as changes to tasks, technical malfunction or using different equipment. Reacting to unforeseen circumstances has been recognised as a factor impacting task management and teamwork (Mitchell et al., 2012; Andersen, Jensen, Lippert, & Østergaard, 2010). Additionally, reacting to sudden changes has been well documented within the aviation industry and is referred to in the context of 'startle and surprise' - which can lead to a pilot freezing or losing situation awareness through the narrowing of attention (Bürki-Cohen, 2010). It stands to reason therefore that pilots would identify the reaction to unforeseen circumstances as a hazard and thereby understand it's influences upon the utilisation of their NTS.

The current results indicate that search and rescue and offshore transport pilots' NTS are influenced by the same key factors. However, these factors vary on an elemental level as a function of the pilots' mission parameters. The results contribute to a growing body of literature surrounding NTS in high-risk industries, specifically those used within rotorcraft operation. In indicating that differing mission parameters allow for different factors influencing NTS, the current research emphasises the need for such factors to be addressed within role-specific NTS training regimes and error prevention strategies.

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