Safety Science 73 (2015) 73–79

Contents lists available at ScienceDirect

Safety Science

journal homepage: www.elsevier.com/locate/ssci

Miscommunication in general aviation: The influence of external factors on communication errors

Brett R.C. Molesworth [a,*], Dominique Estival [b]

[a] School of Aviation, University of New South Wales, NSW, Australia
[b] MARCS Institute, University of Western Sydney, NSW, Australia

ARTICLE INFO

Article history:
Received 11 July 2014
Accepted 7 November 2014

Keywords:
Communication
Errors
Aviation
Safety
Pilot-ATC

ABSTRACT

Miscommunication in aviation remains a serious threat to safety. Factors such as pilots workload, quality of audio signal, accent of pilot or controller, English language proficiency of operator, and failure to use standard phraseology are all thought to contribute to communication errors. Hence, the aim of the present research was to investigate if a relationship existed between four known factors moderating communication and communication accuracy. Seventeen pilots completed a total of eight separate simulated flights (presented in counterbalanced order), which were arranged in four flight pairings and the percentage of accurate transmissions were compared between each flight pairing. The results revealed that requiring four or more items in one radio transmission degraded communication performance. Similar results were noted when pilots were under high workloads. Eliminating prosodic features such as pauses in radio transmissions also increased communication errors; most notably for pilots whose native language was not English. There was no effect of airways congestion on pilot communication performance. The results are discussed from a theoretical and applied perspective.

1. Introduction

"Aviate, navigate, communicate" is an important adage pilots are required to remember. It is therefore unlikely to be fortuitous that miscommunication (i.e., communication errors) features prominently in many aviation accidents. This has not gone unnoticed with renewed emphasis from aviation authorities focusing on aviation terminology as well as language proficiency standards (International Civil Aviation Organization – ICAO, 2007; Moder, 2013), with the ultimate objective of improving safety. However, there are many moderating factors such as pilots' workload, quality of audio signal, accent of pilot or controller, English language proficiency of operator, and failure to use standard phraseology that are likely to contribute to communication errors. Therefore, the main aim of the present research was to investigate if a relationship existed between four known factors moderating communication and communication accuracy.

In general aviation, it is a requirement that all aircraft operating in controlled airspace have a serviceable (i.e., functioning) radio. It is also a requirement that all pilots hold a radio telephony licence. In 2003, the International Civil Aviation Organization introduced minimum levels of English language proficiency for both pilots and air traffic controllers, which came into effect in 2008 within Australia. These requirements, and in particular the latter two, are designed to improve radio transmission skills, and ultimately enhance safety.

The added inclusion of the English language proficiency skills is on top of existing safeguards to protect against communication errors in aviation such as: English as the international language; the use of standard phraseology (e.g., 'roger' and 'wilco' for acknowledgement of instructions); international phonetic alphabet (e.g., Alpha, Bravo, Charlie, Delta, etc.); prescribed pronunciation of letters and numbers (e.g., 'IN dee A' for India, 'wun' for number one, 'nin er' for number nine, one thousand five hundred for 1500); and read-back requirements (e.g., only key elements of the instructions or clearances are required to be read back; Aeronautical Information Publication – AIP, Airservices Australia, 2005).

Notwithstanding these principles, radio transmission skills such as pronunciation, speech rate and accent have been cited as leading contributing factors in communication problems in both commercial aviation and general aviation (EUROCONTROL, 2006; Tiewtrakul and Fletcher, 2010; Estival and Molesworth, 2012). Take call-signs for example, EUROCONTROL (European member state organisation with its central focus on air traffic management) found in a study with 241 airline pilots and air traffic controllers, that twenty per cent of respondents indicated that they experience

* Corresponding author at: School of Aviation, Room 205c, UNSW, Sydney, NSW 2052, Australia. Tel.: +61 2 9385 6757; fax: +61 2 9385 6637.
E-mail address: b.molesworth@unsw.edu.au (B.R.C. Molesworth).

http://dx.doi.org/10.1016/j.ssci.2014.11.004
0925-7535/

communication problem with call signs on a weekly basis. Controller accent was cited as the leading contributing factor (34%) closely followed by controller speech rate (28%), pilot distraction (25%), pilot expectation (22%) and pilot fatigue (20%). Similar findings were evident when respondents were asked about frequency changes: controller accent (51%), controller speech rate (42%) and pilot distraction (43%).

Estival and Molesworth (2009) found similar results when they surveyed 36 pilots from various flight training institutions at Bankstown airport, in Sydney Australia about miscommunication in general aviation. When pilots were asked what they found most challenging in general aviation communication, pilots noted 'understanding other pilots' as most challenging. Subsequent comments from pilots indicated that communicating with non-native English speaking pilots was particularly challenging. In a follow-up study, with 83 pilots from various flight training institutions in both New South Wales (NSW) and the Australian Capital Territory (ACT) in Australia, they found similar results, with 'understanding other pilots as the most challenging aspect of communicating in aviation'. No differences were noted in responses based on native language background i.e., native English speaker (NS) and non-native English speakers (ESL), however understanding non-native English pilots featured predominantly as one issued raised by many pilots. When asked if they had been in a situation where they did not fully understand the instructions from air traffic control, over half of the pilots noted that they had. Estival and Molesworth interpreted these findings as evidence that poor communication skills were a likely factor leading to communication problems.

However, factors generally outside the pilot control can also contribute to miscommunication. For example, Barshi and Farris (2013) found in a pen and paper study with non-pilots that when four or more items were presented in one transmission, communication errors doubled compared to when there were three or fewer items in a transmission. The prosodic features of the message (i.e., intonation, pauses, and stress) may also contribute to communication errors (Estival and Molesworth, 2009). Moreover, presenting information in a transmission without pauses, or any emphasis on important words, is likely to add to communication errors. Pilot workload is also thought to add to communication errors (Lin et al., 2012), with communication itself further adding to workload (Linde and Shively, 1998). Congested radio frequencies are also thought to adversely affect communication performance (Morrow et al., 1993).

The present research attempts to extend the research conducted by EUROCONTROL (2006) and Estival and Molesworth (2009, 2012) with the intent to investigate the impact of factors outside the control of the pilot on communication errors. Specifically, the present research will seek to answer the following four questions:

1. Does the number of items in a transmission, such as four or more items per radio transmission increase pilot communication errors?
2. Do the prosodic features of a message, such as a radio transmission without pauses, increase pilot communication errors?
3. Is there a relationship between pilot workload and pilot communication errors?
4. Does airspace congestion adversely affect pilots' ability to communicate?

2. Method

2.1. Participants

Seventeen pilots (one female), eight of whom were native English speakers (NS) volunteered for the research. The average age of the participants was 30.82 (SD = 13.97) years. The native language of the non-native English speakers (English as a second language - ESL) included: Cantonese (4), Chinese (1), Malayalam (1), Italian (1), Danish (1), Russian (1). On average, the ESL speakers reported to have spoken English for 17.11 (SD = 11.96; range 2–35) years. The research, including all stimuli was approved in advance by the University of Western Sydney Ethics Committee.

2.2. Design

The study comprised a 2 × 4 mixed repeated measures design with language background as the between-groups factor containing two levels (NS vs. ESL), and flight scenario as the repeated measures factor containing four different flight pairings (Pauses, Information Density, Workload, and Frequency Congestion). The four flight pairings (eight flights in total) were presented in a counterbalanced order as per a 4 × 4 Latin square design. A Latin Square design was chosen, as opposed to a balanced Latin square design, because of the undesirable adjacency which a balanced Latin Square would have given to the two flights in each pair. The dependent variable in all flights was communication accuracy.

The ATC transmissions (calls) played to the pilots were prerecorded as separate calls according to flight scenarios designed by the two researchers. The scenarios for each flight were recorded separately, with a male aviation professional with more than 30 years of flying experience as the ATCO. The calls for each flight were then concatenated in a single sound file, with time for pilot answers inserted between each ATC call. In total there were 126 transmission opportunities for each pilot throughout the eight different flights.

As can be seen in Table 1, there were four pairs of flights, with one of the test flights acting as the baseline (easy condition) and the other flight in the pair serving as the experimental flight. Three flight scenarios (flight pairings) were navigation flights, with the fourth scenario an approach to land at a local airport.

The first flight pairing compared read-back errors when ATC instructions contained pauses between items (Flight 1A) vs. no pauses between items (Flight 1B), i.e., 'Pause condition'. In other words, in the no pause condition (Flight 1B) the ATC instruction was one continuous utterance (e.g., "ABC Camden Tower Maintain 3500 and maintain 160 Contact Sydney Centre on 124.55").

The second flight pairing compared read-back errors when each ATC transmission contained no more than 3 items (Flight 2A) vs. when ATC instructions contained 4 or more items (Flight 2B), i.e., 'Information Density condition'. For example, compare the ATC transmission "ABC, Sydney Centre. Climb to 4500. Track 250." in Flight 2A, with "ABC, Sydney Centre, climb to 4500. Track 250. Traffic is a Cessna at your 9 o'clock, Report sighted." in Flight 2B.

Table 1
Overview of the four flight pairings.

Flight #	Flight description	Departure point	Destination point	# Of possible pilot transmissions
1A	With pauses	Camden	Wollongong	16
1B	Without pauses	Camden	Wollongong	16
2A	3 or fewer items per transmission	Camden	Goulburn	18
2B	4 or more items per transmission	Camden	Goulburn	20
3A	Low workload	Camden	Canberra	13
3B	High workload	Camden	Canberra	13
4A	No radio congestion	Entry point 2RN	Bankstown	11
4B	High radio congestion	Entry point 2RN	Bankstown	11