Improving radio communication in General Aviation: a preliminary investigation

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Abstract
English Language Proficiency (ELP) has been identified as an integral part of international aviation safety (MacBurnie, 2004). As such, the International Civil Aviation Organization (ICAO) has mandated that all new pilots and Air Traffic Control (ATC) personnel pass an ELP test prior to obtaining their qualifications. Although this is widely expected to have a positive impact on safety, there is yet limited evidence in General Aviation (GA) to suggest that improvements in communication have been forthcoming. Therefore, the main aim of the present research was to investigate the impact of ELP on communication in GA. In a preliminary study, 36 pilots of varying flight experience and from 9 different language backgrounds completed an anonymous questionnaire regarding their experience with radio communication. Qualitative comments from pilots indicate that the use of English as a second language contributes to communication difficulties in GA. A series of planned Wilcoxon Signed-Rank Tests revealed 'Understanding other pilots' to be the most challenging task in radio communication, followed by 'Remembering what you have to say', 'Reading back', 'Saying what you have to say' and 'Understanding ATC'. A series of Kruskal-Wallis non-parametric analyses revealed that all pilots, irrespective of flight experience and native language, ranked the challenges in radio communication similarly. The preliminary conclusion is that pilots, irrespective of language background, find communication with other pilots significantly more challenging than with ATC. This challenge is not mitigated by flying experience and is further increased when communicating with pilots whose native language is not English. These results suggest that improvements in ELP are only part of the solution. Future research is required to determine the impact of other contributing factors, e.g. quality of aircraft radio transmissions, pilots' comprehension skills, and pilots' mental model (expectation), on effective communication in GA.

Introduction
Commercial aviation, as an international operation, employs English as the sole international language and proficiency with the English language has been identified as an integral part of international aviation safety (MacBurnie, 2004). In order to address this, the international aviation governing body – International Civil Aviation Organization (ICAO) – has mandated that all new pilots and Air Traffic Control (ATC) personnel must pass an English Language Proficiency (ELP) test prior to obtaining their qualifications. In Australia, the local authority – Civil Aviation Safety Authority (CASA) – required this rule to come into effect in March 2009 and developped audio testing material to evaluate pilots' comprehension in a variety of radio communication situations. While this requirement is widely expected to have a positive impact on safety within aviation, there appears to be a number of teething problems (Alderson & Horak, 2009). Anecdotal evidence suggests that these may stem from training organisations focusing on teaching pilots to use standard English, with some aviation specific phraseology and jargon. While the teaching of standard conversational English does include using pauses in appropriate places, as well as intonation to emphasise important or relevant information, these non-verbal features are not used by ATC in the way they are in normal conversation. In fact, the lack of intonation, rhythm, and pauses which are typical of rapid radio communication in the aviation environment are known to be particularly problematic since no visual cues are present (McMillan, 1998; Prinzo, 2008; Nevile, 2008).

Take for example the common aviation phrase '*Mike India Charlie* (aircraft call-sign) *report final*'. Outside the aviation context, the final word in such a request will more often than not end with an inflection (i.e., increase in pitch) which typically denotes either a question or that a response is required. It is this lack of inflection in the aviation context which has the potential to confuse.

Communication problems within aviation appear further compounded by the reliance on, and need for, radio transmissions which result in a degraded speech signal. Moreover, the cockpit is a noisy environment and the presence of noise makes it more difficult to understand speech. This is most evident for EL2 speakers (Gat and Keith 1978). Shimizu, Makishima, Yoshida, and Yamagishi, (2002) found that, as the signal to noise ratio increased (white, pink, and aircraft noise), native Japanese speakers found it much harder to discriminate between different English phonemes. According to Mayo, Florentine, and Buus, (1997) the difficulty in discriminating between English phonemes for EL2 speakers is off-set with years of exposure to English, but never reduces to that for Native Speakers (NS).

The main aim of the research was to investigate communication challenges within General Aviation (GA) and to assess the utility of language technologies as a means of mitigation. The present research reports on the findings of a preliminary study examining the most challenging aspects of radio communication in GA.

Method

Participants

Thirty-six pilots from various flight training institutions located at Bankstown airport, Sydney Australia, participated in the study. The mean flight experience of the pilots was 342 hours (range 15 - 2,800). Twelve of the pilots held a Private Pilot Licence, while eleven held a Commercial Pilot Licence. The remainder of the pilots had passed the General Flying Progress Test or were undergoing training to obtain this licence (Pre-solo and Solo stages of training) (see Table 1).

Nine language backgrounds were represented. Twenty-four pilots reported their first language to be English (i.e. NS), either Australian (23) or British English (1). The non-native speakers of English (i.e. EL2) identified their native language as: *Tamil* (4), *Cantonese* (3), *Malaysian* (2), *Malayalam* (1), *Telugu* (1), *Urdu* (1) and *Korean* (1). On average, the EL2 pilots reported having spoken English for 14 years (range 2 -25).

Table 1

Number of pilots distributed across flight training level, flying experience, and whether English is second language ("*" denotes that some respondents did not answer the question)

Training Level	# of Participants	Mean Flight Hours	EL2
Pre-Solo	2	15*	2
Solo	5	48*	4
GFPT	5	53	2
PPL	12	222*	3
CPL	11	701*	1
Total	35*	342	12*

Stimuli

A paper-based survey was employed for the study. It was designed to elicit self-reports of radio communication problems experienced and was not intended to assess the pilots' level of English proficiency. The survey was anonymous and consisted of six questions. The first two collected information about the pilots' level of English proficiency and their level of flight training, the other four focused on pilots' experience with radio communication – both with other pilots and with ATC.

Procedure

Prior to distributing the survey, permission was sought from the Chief Flying Instructor (CFI) at all flight training institutions. Paper copies of the survey were left with the CFI, with a sealed box to collect the completed questionnaires. On average, flight institutions had two weeks to complete the surveys. The research was approved by the University of Sydney Ethics Committee.

Results

Challenges in Radio Communication

Since the main goal of the research was to examine what pilots find most challenging in aviation communication and specifically whether any differences existed between NS and EL2 pilots, they

were asked to rank in order of difficulty five common aviation communication tasks, namely: (a) *Remembering what you have to say*; (b) *Reading back*; (c) *Saying what you have to say*; (d) *Understanding ATC'* and (e) *Understanding other pilots*.

Eleven (11) pilots reported the most challenging component of radio communication to be *Understanding other pilots*. This was followed by *Remembering what you have to sa*' (9), *Reading back* (5), *Understanding ATC* (2) and *Saying what you have to say* (2). Thirteen pilots (NS as well as EL2) had problems answering this ranking question as formulated (with 1 = most difficult and 5 = least difficult). To ensure data accuracy, respondents who gave no or incompatible rankings (5 possible errors) on this question were excluded from the subsequent analysis.

Based on the above distribution, a series of planned Wilcoxon Signed-Rank Tests were employed to examine the order in which pilots ranked, in terms of difficulty, these five aviation communication tasks. The non-parametric alternate to the Dependent–Samples t Test (Wilcoxon Signed-Rank Tests) was used since the data violated the assumptions underpinning parametric tests (i.e., small sample sizes and homogeneity of variance). With alpha set at .05, the median rank for *Remembering what you have to say* (*Mdn* = 2.57, Range = 4) was significantly higher than *Understanding ATC* (*Mdn* = 3.71, Range = 4), z (N = 21) = 1.99, p = .047, r^2 = .19; the median rank for *Understanding other pilots* (*Mdn* = 1.95, Range = 3) was significantly higher than for *Understanding ATC* (*Mdn* = 3.71, Range = 4), z (N = 21) = 3.69, p = .000, r^2 = .65; and the median rank for *Remembering what you have to say* (*Mdn* = 2.57, Range = 4) was also significantly higher than for *Saying what you have to say* (*Mdn* = 3.62, Range = 4), z (N = 21) = 2.28, p = .023, r^2 = .25.

Based on the above analysis, *Understanding other pilots* (*Mdn* = 1.95, Range = 3) was found to be the most difficult followed by *Remembering what you have to say* (*Mdn* = 2.57, Range = 4), *Reading back* (*Mdn* = 3.14, Range = 4), *Saying what you have to say* (*Mdn* = 3.62, Range = 4), with *Understanding ATC* (*Mdn* = 3.71, Range = 4) as the least difficult.

In summary, if the tasks were to be ranked, the order would be (# 1 most challenging);

1. Understanding other pilots,
2. Remembering what you have to say,
3. Reading back,
4. Saying what you have to say,
5. Understanding ATC.

Determiners of task difficulty

In order to determine whether the differences observed with task difficulty could be explained by native language or qualification (licence type), a series of one-way analysis of variances (ANOVA) were employed. Since the data violated the assumptions underpinning parametric tests (i.e., homogeneity of variance), Kruskal-Wallis non-parametric tests were used. With alpha set at .05 the results failed to reveal any statistical significant differences, with largest $X^{2,}$ X^2 (3, 20) = 5.77, p = .12. This result suggests that neither native language nor qualification was an influencing factor in what pilots found difficult with radio communication.

Pilots were also asked to suggest other areas of difficulty in radio communication. Only three answers were given to that question, and all three mentioned EL2 pilots:

(#1) 'pilots whose first language is not English'
(#20) 'it's very hard when pilot is mumbling/broken english' (sic)
(#36) 'Bloody Indians' (sic)

Pilots were given the opportunity to provide narrative examples of communication problems, excluding radio malfunctions. Respondent #6 reported an incident which was in fact due to a radio problem as opposed to a communication problem, while respondent #36 reported an account of an incident where two EL2 pilots, designated as 'Indians', could not be understood by other pilots on approach at a regional airport. It is important to note that this is the same pilot who used the phrase 'Bloody Indians' in the previous question. This derogatory phrase is often heard to refer to overseas student pilots in general and it reflects a prejudice against Indian student pilots which unfortunately appears to be very strong in the Australian General Aviation community (and which, as recent events have shown, seems to be reflected in the wider community).

Communicating with ATC

Finally, pilots were asked about situations where either they did not fully understand what ATC was telling them, or where ATC asked them to repeat a transmission. Twenty-one and twenty-six pilots

replied to each question, respectively. A similar distribution across native languages was present in both responses, with fourteen and seventeen NS. Irrespective of native language, the most notable instances of the first situation occurred when receiving a clearance from ATC (4 pilots) and when instructed of a runway change (4). In contrast, ATC found understanding transmissions relating to aircraft call-signs to be the most difficult (10), followed by clearance information (7). As we would expect from the point of view of the theory of communication, cases of ATC not understanding pilots and of pilots not understanding ATC occur when the message is less predictable from the context.

Conclusion

Communicating effectively via the radio in general aviation is a challenging task for most pilots. Understanding other pilots appears to pose the greatest challenge and this is irrespective of native language or licence qualification. By contrast, pilots in fact found communicating with ATC to be the least challenging task. This may be explained in part, to the intensive training provided to ATC, and to the standardized phraseology now regularly employed (Cushing, 1994; Hutchins & Klausen, 1996). In addition, there is evidence to suggest that the quality of the transmission between two aircraft negatively affects effective communication (Shimizu et al., 2002). Finally, there is some evidence to suggest that the standard of English employed by EL2 pilots contributes to the challenges of radio communication in GA.

Future research needs to be directed towards investigating the underlying problems associated with radio communication, such as comprehension, phraseology, intonation, speech irregularities (i.e., utterances) and the use (or misuse) of pauses. Furthermore, future research should be directed towards quantifying the frequency of communication problems within GA and whether ATC experiences are similar to that of their flying counterparts.

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