Research on Aviation English from a LHUFT (Language as a Human Factor) Perspective

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Abstract: This article is based on a presentation on recent research into Aviation English within a LHUFT perspective conducted in a private university in Brazil. The article describes this perspective to Aviation English and illustrates how it is being used with undergraduate student pilots in the Aeronautical Science Program. Miscommunication episodes in aviation have historically caused accidents, incidents, and near misses and so need to be addressed in a way that encompasses aspects closely associated with language factors, such as technical, procedural, and cultural factors. Linguistic issues are the starting point and can be analyzed in a more thorough manner if considered along with underlying elements that account for a given communicative behavior. The following research topics fit into this proposal: Cross-cultural factors underlying air-ground communications between native and non-native speakers of English; miscommunication issues in the SBPA radiotelephony between the ATCO and foreign pilots and a taxonomy-based classification and analysis of aeronautical accidents considering language as a human factor in aviation. We conclude that a number of challenges can be overcome with improvements in pilot training regarding a wider perspective of aeronautical communication, and that can be done through research. The LHUFT perspective seems to allow for a broader approach to better understand miscommunication episodes and offer tools to be used in training.

Keywords: Research, Aviation English, Language as a Human Factor (LHUFT), Pilot training.

Introduction

Communication in aviation has long been an issue that poses threats to safety globally (S. Cushing 1997, B. Sexton/ R. Helmreich 2000, A. Pacheco/ G. Souza 2018, E. Mathews et al. 2022). Although much progress has been seen in aviation engineering and security, for example, investigation into the factors that lead to specific communication problems has not evolved at the same pace. The need to have a better understanding of the use of the language of aviation is the reason why more and more research is imperative. Possible communication problems have been more recently highlighted by the operational community through, for

example, an FAA Safety Briefing (2020) documentaries[1] and the academic community, as featured in two volumes of the journal *The ESPecialist* in 2020[2]. However, linguistically detailed studies focusing on investigations of aeronautical accidents and incidents are still scarce.

This is the core of the Language as a Human Factor (LHUFT) perspective. Proposed by Professor Elizabeth Mathews in 2013 (E. Mathews 2013), the framework of analysis includes four factors that account for communication in aviation, ranging from language, technical, procedural and cultural aspects. Linguistic factors lie in the center and should be considered the starting point of the analysis, given the need to understand some of the specificities of language in aviation. Technical, procedural, and cultural communication factors tend to be better understood by aviation operational experts.

Collegiate pilots can greatly benefit from investigation approaches that manage to account for issues that will be part of their daily operational routine. In their undergraduate level, students must comply with requirements and write a final monograph paper in order to get their degree, and this is an opportunity for some to deepen their knowledge on aeronautical communications.

This article aims to explore some of the ideas presented in an online seminar in October 2022 regarding the possibilities of conducting research in an academic environment through the LHUFT Perspective. Firstly, it describes the main aspects comprised by the LHUFT perspective. Next, it showcases some research possibilities that have been conducted within this framework to illustrate how it is being applied to academic research. As we will see, not only do such propositions allow for more studies in the field, but they also encourage better training practices as they shed new light into particular features of the use of language in aviation.

1. The Language as a Human Factor (LHUFT) Perspective

Aeronautical operations are complex in nature, and communication has been an issue of concern: it is fundamental for the system to work, involves a wide array of cognitive skills, and is directly influenced by cultural, technical, and psychological variables. Miscommunication episodes have historically caused accidents, incidents, near misses and need to be not only acknowledged, but explored, better understood, and so addressed adequately.

In 1990, the crash of Avianca 052 in Cove Neck, NY is an example of communication failure: the pilots did not successfully manage to communicate the low fuel situation to the air traffic controllers due to lack of language proficiency. A closer analysis shows that linguistic problems were observed in the lexical, structural, and pragmatic levels, and they may be associated with underlying aspects that involve the cultural behavior of their native country and the safety culture of the company (E. Mathews 2019).

In 2012, an EVA Air Flight departing from Los Angeles illustrates how episodes of miscommunication can easily occur and why training and awareness are so relevant. In that

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[1]https://edition.cnn.com/2023/03/11/politics/close-calls-airplanes-runways-what-matters /index.html; https://edition.cnn.com/travel/article/aviation-safety-united-states/index.html; https://www.forbes.com/sites/brianbushard/2023/03/06/two-planes-clip-at-boston-logan-following-multiple-close-calls-around-the-country/?sh=1f6c088d4afc
[2] https://revistas.pucsp.br/index.php/esp/issue/view/2475

case, pilots failed to comply with instructions immediately and almost collided with another aircraft. Furthermore, instructions were not clear and were not paraphrased by the controller, who seemed unaware of, and insensitive to, the pilots' possible language difficulty. The incident was, thankfully, classified as a near miss (A. Pacheco 2018).

Intercultural aspects have been mentioned as potential triggers for certain linguistic behaviors (A. Monteiro 2012, A. Monteiro 2019) and consequently need to be accounted for in language analysis of aviation communications. Intercultural language competence is key for successful aeronautical communications internationally (A. Borowska 2013, A. Borowska 2016). Inherent skills regarding best communication strategies in multicultural and intercultural contexts must be integrated in pilot training practices in order to promote full and constant awareness during flight operations. More information on miscommunication episodes from accidents, incidents or other events will allow for richer training resources and research can be a tool for that. E. Mathews et al. (2022: 106) claim that

> Understanding the role that language plays in aviation is a key element in accident investigations because investigators need to be able to issue meaningful and actionable recommendations to prevent such future accidents and improve safety. No investigation of human factors in aviation can be considered complete without a methodical, systematic, and informed review of possible language factors.

The LHUFT Research perspective (E. Mathews 2021) posits that linguistic issues require the same degree of systematic and expert analysis as given to all other aspects of human performance and in a display in which they can be analyzed in a more thorough manner if considered with underlying elements that account for a given communicative behavior. A LHUFT research center aims to support "improved aviation safety through better understanding of the issues around language and culture in flight safety" [3]. Investigation of the role of language in aviation accidents and research into language as a human factor in aviation communications are identified as gaps that still need to be addressed, along with standards of aviation English teaching, teacher training and testing.

E. Mathews et al. (2022: 100) review the investigation of language factors in aviation accidents based on a systematic review of accident reports. The research question was "Are language factors adequately identified and analyzed in accident investigation reports?" and they concluded that language does play a complex role in aeronautical operations which is not limited to radiotelephony and that the identification of language factors is obscured in many accident investigation reports

The Human Factors Analysis and Classification System (HFCAS), developed by D. Wiegmann/ S. Shappell (2003: 70) aims "to define the holes in the Swiss cheese and to facilitate the application of this model into accident investigations and analysis". It seems too generalist, though, as it mentions "poor communication" and "misinterpretations of air traffic calls" only in the selected examples of preconditions of unsafe acts, under "personnel factors". No detail is given as for the treatment of specific language factors into the model. Similarly, the ICAO CAST Document is an attempt to address significant factors that underlie the occurrence of accidents and incidents through a taxonomy: the Accident/Incident Data Reporting (ADREP) taxonomy, which is made of a "compilation of attributes and the
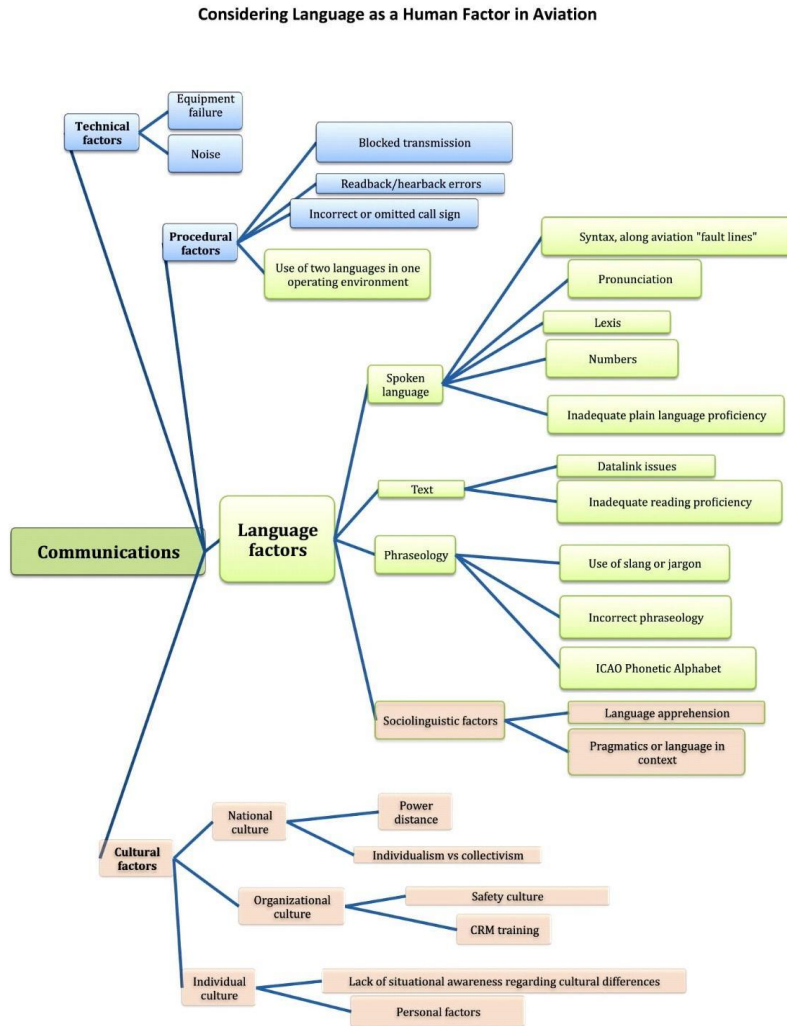
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[3] https://commons.erau.edu/db-lhuft/.

related values"[4]. Two of these links seem to address communication issues more closely: the Descriptive and the Explanatory Factors, the latter mentioning language four times:

> Psychological-comprehension (Comprehension) Factors related to comprehension difficulties, e.g. in communication, might be associated with language or accent or understanding of procedures. (p.9)

> The interface between humans in relation to language (Human interface-language) Factors related to the interface between humans in relation to the use of a particular language, e.g., English in a French speaking area. (p. 26)

Although intended to support the identification of communication factors, it is insufficient in terms of presenting language data for specialists to use in aviation language training. Investigation of the role that communication plays in aviation safety should incorporate more specific language information so that it can be addressed as it needs to. Within the LHUFT perspective, a Taxonomy is proposed in order to allow for a more comprehensive view of language factors in addition to other communications factors, such as technical, procedural and cultural factors, that may be intimately connected to particular language occurrences (E. Mathews 2013). The figure below displays the first iteration of a Taxonomy of Communication factors.

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[4] https://www.icao.int/safety/airnavigation/AIG/Pages/ADREP-Taxonomies.aspx.

Considering Language as a Human Factor in Aviation

Categories are representative not inclusive   Elizabeth Mathews 2013.

Figure 1. Considering Language as a Human Factor.

The first draft of the Taxonomy of Communication factors was developed in 2013 and is an attempt to consider all relevant elements that may have a significant role in miscommunication events in accidents and incidents. Technical communication factors are those that "impede communications: equipment failures, or static or noise on the radio frequency" (E. Mathews, A. Pacheco/ A. Albritton 2019: 73). Procedural communication factors are those which deter communication, such as blocked transmissions, omitted callsigns, readback or hearback problems, or the use of two languages in one operating environment. Cultural factors are well known to affect communication and can be related to some ideas developed by G. Hofstede (1997) regarding power distance, individualism versus collectivism, as well as to broader concepts involved in national, organizational, and individual culture[5].

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[5] For more details, see E. Mathews, A. Pacheco and A. Albritton (2019).

This model of communication factors in aviation has been revised and updated, and has been incorporated into a Handbook (E. Mathews 2021: 5). The *Language as a Factor in Aviation Accidents and Serious Incidents: A Handbook for Accident Investigators* was developed to "support accident investigators in the identification and consideration of possible language factors in aviation accidents and serious incidents" … and to provide "guidance, background information, and tools that will assist accident investigators in conducting a systematic review of possible language factors." The updated Taxonomy of Communication Factors below, retains the primary identification of four types of communication factors in aviation: technical, procedural, cultural, with the focus on language factors.
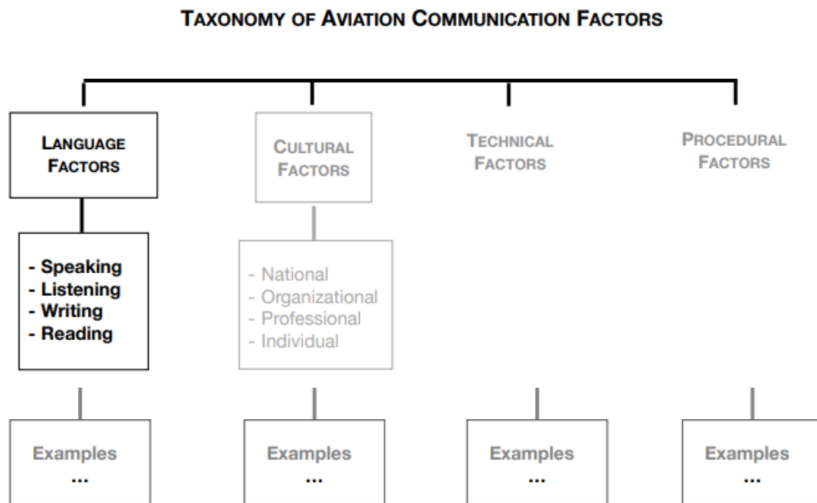

Figure 2. Taxonomy of Aviation Communication Factors by E. Mathews (2021).

According to this model, the language factors are put prior to others and headed by language skills, which seems to be an appropriate perspective from a language analysis approach. These factors are then followed by the other factors (cultural, technical, and procedural). Research continues on the use and applicability of this model.

Within the LHUFT Perspective, Language as a Human Factor in Aviation courses have been offered by a private university in Brazil, both in the Undergraduate and Graduate levels, not only to pilots, but also to professionals directly involved in aviation who need to be aware of language use and its impact in operations. The main goal is to encourage the audience to reflect about specific factors that impact safety from the language perspective. Among the activities proposed, research is highlighted. Some of the studies are described below.

2.   Research within the LHUFT Perspective

The following analysis results from Final Monograph projects which undergraduate students have to comply with in order to obtain a degree in Aeronautical Science in a private university in Brazil. They can select from a topic that has appealed to them mostly along the Program, and some elect to explore their knowledge on language and aviation. They have the supervision of a specialized professor, and the final work is evaluated by two peer reviewers – professors and/or researchers involved in the field.

One outstanding aspect of the research proposition is the opportunity for pilots to develop awareness on such relevant topics in the end of their college experience: they gather more elements to use in their upcoming communication exchanges in operations. Additionally, the fact of having multi and interdisciplinary professionals analyzing one phenomenon is an advantage as it takes into account a higher number of variables: what a teacher has in mind when investigating a miscommunication episode can be very relevant, and that can be reinforced or expanded by what a pilot has in mind because the latter contemplates the whole operational scenario. In this regard, the following studies have been recently developed as an attempt to shed light on the use of language in aviation from the LHUFT perspective.

2.1. Miscommunication issues in the SBPA radiotelephony between the ATCO and foreign pilots

Based on Barbara Clark's "Data analysis findings and best practice recommendations'' (2017), this study is being developed in Porto Alegre, Rio Grande do Sul, Brazil. The main idea is to assess the most frequent miscommunication errors in the Salgado Filho International Airport (SBPA), the local airport, and how they affect the whole operation. The analysis aims at non-native English speakers (NNES), on both sides of the radiotelephony communication, that is, pilots and ATCOs. Most international flights in this city come from countries that have a Hispanic language as their mother language and, because of that, this study is particularly useful and necessary.

A. Borowska (2016) claims that only 25% of aviation English (AE) users are native speakers, meaning that 75% of the people who use AE on a daily basis are NNES. That information tells us that AE is not natural for most users; rather it is a technical language and has to be learned by all the parties who want to communicate in the aviation context (A. Pacheco 2019). The flight deck can be complex even in standard operations, and it requires accurate situational awareness to ensure a secure flight. When pilots or controllers are operating in a multicultural situation, either flying abroad and communicating with non-native English speakers, or controlling non-native English speaking pilots, the attention should be higher. The lack of attention or the lack of proper language training can possibly cause a miscommunication problem that could lead to serious incidents or even accidents (Tenerife in 1977 as an example). In this study we are also analyzing the ATCO communication, because, as B. Clark (2017) found out in her research, most miscommunication problems can be attributed to ATCOs rather than to pilots.

To accomplish the research, a publicly available source called Live ATC[6] is being used. One of the challenges when using this source of information is the constant and autonomous channel changing in the radiotelephony, that is, from time to time it changes the frequency that one is listening to, from Tower, Ground, Center and the Approach Control (APP). Thus, it may not be possible to collect all the possible data; nonetheless, in the conversations collected, miscommunication issues have already been identified.

As for the method, it is exploratory empirical research, which aims to describe data qualitatively. The selected communication exchanges (10) are firstly heard and recorded as they take place. Secondly, the dialogues are transcribed and analyzed, searching for possible miscommunication problems related to accent, misunderstanding, readback errors, confusion

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[6] https://www.liveatc.net/.

and hearer expectation. All the records are registered on a table (as below), containing the number of the flight, occurrence, and expansion of the problem.

FLIGHT	ISSUE						EXPANTION
	ACCENT	M. UNDERSDT.	R.B. ERROR	CONFUSION	H. EXPECTATION	NO ISSUES	-

Table 1. Miscommunication issues by N. C. Hemp (2022).

Although it is a study in progress, but a preliminary analysis shows that the main problems regarding miscommunication are related to hearer expectations, readback errors, accents, and bilingualism in the radiotelephony. Those were the most frequent errors found on B. Clark's (2017). Additionally, they are closely related to factors displayed in the Taxonomy of Communication Factors (E. Mathews 2023) such as Inadequate plain language proficiency and pronunciation (language factors); readback errors, and use of two languages in one operating environment (procedural factors) and lack of situational awareness regarding cultural differences (cultural factors), given the fact that people mistakenly take for granted that Brazilian, Portuguese, and Spanish are similar to the point of being used interchangeably.

2.2. Cross-cultural factors underlying air-ground communications between native and non-native speakers of English

Bearing in mind that 75% of aeronautical communication in English is done by non-native English speakers (A. Borowska 2016), the study conducted by D. Forneck (2022) proposes a reflection on the behavior and standardization of English in aeronautical communication considering its cross-cultural factors between pilots and controllers. It focuses on situations arising between native X native, native X non-native and non-native X non-native speakers of English, considering their attitudes and their linguistic and operational behaviors.

The study explored four cases of real communication exchanges between pilots and ATCOs who are both native and non-native speakers of English in order to investigate the underlying factors for possible miscommunication issues based on the following questions: 1) Who made the most use of plain English: pilots or ATCOs? Did they paraphrase? and 2) What factors might have been underlying the ATC/Pilot communication attitude? The LHUFT taxonomy was used as a method to analyse and organize the factors that are associated with the "causes" of the communication failure, classifying the communication factors into technical, procedural, linguistic and cultural categories.

The following cases were selected based on the characters featuring the communicative events.

Case 1: Flight 104 on 07/22/2018, Aer Lingus Airline. Native pilots and native ATCO.

Case2: Flight 503, Etihad Airways. Non-native pilots and Native ATCO.

Case 3: Flight 965 on 12/20/1995, American Airlines. Native pilots and Non-native ATCO.

Case 4: Flight 763 and Flight 1907 on 11/12/1996, Saudi Arabian Airlines and Kazakhstan Airlines. Non-native pilots and non-native ATCO.

The results show, regarding question 1, both pilots and controllers used plain English in some cases, and this may be linked to lack of knowledge on the use of aeronautical phraseology or to resolve doubts at certain times in which only aeronautical phraseology was not

enough. As for question 2, most of the issues are linked to cultural factors, which seems to cause the attitudes of pilots or controllers to change. "Lack of situational awareness regarding language or cultural differences" was the most outstanding factor in the analysis, justified by the disregard of native speakers of English (pilots and ATCOs, in cases 2 and 3 of adjusting their language to get their message through as successfully as possible. Furthermore, as for specific language factors, it was noticed that Plain English is still widely used by native English speakers, and lack of language proficiency was a significant issue on behalf of non-native speakers, which contributed to unsuccessful communication.

2.3. A Taxonomy-based Classification and Analysis of aeronautical accidents considering language as a human factor in aviation

A. Pacheco/ G. Souza (2018) attempt to offer an overview of concepts encompassed by the LHUFT approach (E. Mathews 2022), highlighting the main points in the area of human factors more immediately involved in the discussion. Then, through a qualitative methodology, they present a taxonomy-based analysis used to expand examples of specific communication problems, to illustrate it as a possible method of classification and analysis.

The original study had to be conducted in Brazilian Portuguese, and the chart below is an illustration of how the analysis was performed.

Fator Principal	Subfator	Fator Específico	Acidente/ incidente	Frase/ Palavra-chave
1.Fatores Técnicos	1.1 Falha de equipamento		Charkhi Dadri/ 1996/ India	O operador não dispunha de equipamento completo
	1.2 Ruído			
2. Fatores Procedurais	2.1 Transmissão bloqueada			
	2.2 Erros de cotejamento		Informação indisponível em Cushing (1994)[25]	ATC: "hold short" Piloto: "Oh sure"

Figure 3. Expanded Taxonomy.

A table was built to account for each factor and its subfactor, as displayed in the Taxonomy, unfolding with an accident/incident or event which features a miscommunication issue and followed by the sentence/phrase or evidence that justifies that choice. As seen, the determination of specifically linguistic factors of the taxonomy allowed us to classify, in a clearer way, some occurrences identified in relation to the use of language in the aeronautical context. Without this more specific perspective of analysis, linguistic factors have been vaguely registered and categorized either as "communication" or "language barrier" problems, which is not clear enough for the aeronautical community to deal with these issues appropriately, for instance including well-designed awareness activities in training.

The accident/incident reports that are available for consultation in the ASN database are organized in a standardized way and show, in addition to the description of the episode, the probable cause and classification. Rarely do we find the problem of "communication failure" included in the description of the causes of the episode, and even more rarely in its classification. Probable or immediate causes are described as "crew failure to comply...",

"navigation error" etc. If we understand the use of language as a human communication resource for problem solving, we should recognize the real importance of basic language proficiency in air operational safety. A navigation problem, or a problem with equipment, or a lack of fuel, for example, can be managed through the appropriate use of language. Therefore, it is through language that many problems are solved and communicated. This causes the "language" factor to be understood as an interface of all other factors and, at the same time, belittled or even neglected when placed together with a problem of another nature, such as, for example, a technical failure.

Conclusion

Aeronautical communications are complex in nature and need to be addressed in a way to tackle the most immediate language issues that may compromise safety. One of the ways to do that is through research, especially if that can be conducted by specialized professionals who can share their expertise to promote interfaces in the investigations. The article explored the Language as a Human Factor Perspective, an approach to explore language occurrences through a broader framework and analysis and allows for multiple factors to be accounted for as causes of miscommunication. It shows to be a valuable tool for this kind of analysis and can be improved as more research is encouraged.

We believe that the contribution of studies and research with the use and improvement of a taxonomy, such as the one we are developing, could have a significant impact on the aeronautical context. Language, as a human factor in aeronautical communications and as a means for solving problems, merits more attention and formal emphasis, so that studies such as those referred to in this article can offer a contribution in this regard.

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