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The influence of air activity removal on the performance an F-5M pilot[1]

La influencia del alejamiento de la actividad aérea en el rendimiento del piloto de F-5M[1]

A influência do afastamento da atividade aérea no desempenho do piloto de F-5M[1]

Andrei Henning Salmoria[I]

ABSTRACT

This scientific paper proposes to assess to what extent the time away longer than 90 days influences the performance of expert pilots of the F-5M aircraft in airborne visual combat missions. As a theoretical basis, we used the studies by Mager and Pipe (1979) on performance problems and Stillon (1999) on the skills of fighter pilots in the USAF. Thus, the skills required for the F-5M pilot in the WVR missions were identified in the research of Fórneas (2015). Later, in order to identify which skills are affected when the F-5M pilot is removed for more than 90 days from the WVR missions, a five-point Likert scale questionnaire (1932) was forwarded to 39 pilots from three F-5M FAB Squadrons that remained more than 90 days without flying this type of mission in the years of 2016 and 2017. The skill degradation was analyzed in two ways: as a set and separated by general skills and air-air (BIGELOW et al., 2003). Likewise, the pilots were analyzed in groups and separated by experience levels. The results indicated the need to establish new limits for the training frequency. Thus, the conclusions obtained by this work will serve as a basis for future decisions about the training of fighter pilots and the consequent maintenance of the skills obtained in the initial trainings, being useful even to the formulation of the F-39 - Gripen training program.

Keywords: Removal. Airborne activity. Performance. F-5M.

RESUMEN

Este artículo científico propone evaluar en qué medida el alejamiento de más de 90 días influye en el desempeño de pilotos experimentados de la aeronave F-5M en las misiones de combate aéreo visual. Como base teórica, se utilizaron los estudios de Mager y Pipe (1979) sobre problemas de rendimiento y Stillon (1999) sobre las habilidades de los pilotos de caza en la USAF. De esta forma, se identificaron en las encuestas de Fórneas (2015) las habilidades necesarias para el piloto de F-5M en las misiones de WVR. Posteriormente, para identificar qué habilidades se ven afectadas cuando el piloto de F-5M se aleja por más de 90 días de las misiones de WVR, se envió un cuestionario de cinco puntos en la escala de Likert (1932) a 39 pilotos de tres Escuadrones F-5M de la FAB que se quedaron más de 90 días sin volar ese tipo de misión en los años 2016 y 2017. La degradación de las habilidades fue analizada de dos maneras: en conjunto y separadas por habilidades generales y aire-aire (BIGELOW et al., 2003). Asimismo, los pilotos fueron analizados en grupo y separados por niveles de experiencia. Los resultados indicaron la necesidad de establecer nuevos límites para la periodicidad del entrenamiento. Por lo tanto, las conclusiones de este trabajo servirán de base para futuras decisiones sobre la formación de los pilotos de caza y el posterior mantenimiento de las habilidades obtenidas en la formación inicial, además de ser útil para la formulación del programa de formación del F-39 - Gripen.

Palabras clave: *Alejamiento. Actividad aérea. Rendimiento. F-5M.*

I. Second of the Fifth Aviation Group (2nd/5th GAV) – Parnamirim/RN – Brazil. Captain Aviator of the Brazilian Air Force (FAB). E-mail: salmoriaahs@fab.mil.br
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The acronyms and abbreviations contained in this article correspond to the ones used in the original article in Portuguese.

[1] F-5M: American aircraft operated by FAB since 1975. In 2005, its systems were modernized by the Brazilian Aeronautics Company (EMBRAER), hence the designation F-5M.

RESUMO

Este artigo científico propõe avaliar em que medida o afastamento acima de 90 dias influencia no desempenho de pilotos experientes da aeronave F-5M nas missões de combate aéreo visual. Como base teórica, foram utilizados os estudos de Mager e Pipe (1979) sobre problemas de desempenho e Stillon (1999) acerca de habilidades de pilotos de caça na USAF. Dessa forma, foram identificadas nas pesquisas de Fórneas (2015) quais as habilidades necessárias ao piloto de F-5M nas missões de WVR. Posteriormente, a fim de identificar quais habilidades são afetadas quando o piloto de F-5M fica afastado por mais de 90 dias das missões de WVR, foi encaminhado um questionário de cinco pontos na escala de Likert (1932) a 39 pilotos de três Esquadrões de F-5M da FAB que ficaram mais de 90 dias sem voar esse tipo de missão nos anos de 2016 e 2017. A degradação das habilidades foi analisada de duas maneiras: em conjunto e separadas por habilidades gerais e ar-ar (BIGELOW et al., 2003). Igualmente, os pilotos foram analisados em grupo e separados por níveis de experiência. Os resultados indicaram a necessidade do estabelecimento de novos limites para a periodicidade do treinamento. Dessa forma, as conclusões obtidas por este trabalho servirão de embasamento para decisões futuras acerca do treinamento de pilotos de caça e da consequente manutenção das habilidades obtidas nas formações iniciais, sendo útil inclusive à formulação do programa de treinamento do F-39 - Gripen.

Palavras-chave: *Afastamento. Atividade aérea. Desempenho. F-5M.*

1 INTRODUCTION

The First Fighter Aviation Group (1st GAvCa), the First of the Fourteenth Aviation Group (1st/14th GAV) and the 1st Air Defense Group (1st GDA) are similar organizations of the Brazilian Air Force (FAB) that have a double assignment: to train new F-5M pilots and keep the pilots operational ready for missions.

The mission to train and remain prepared for combat is an expensive focus for the nation, as highlighted in the National Defense Strategy (BRAZIL, 2013).

> Despite the difficulty, it is indispensable for the Armed Forces of a Country with the characteristics of Brazil to maintain, in the midst of peace, the impulse to be prepared for combat and to cultivate, on behalf of this preparation, the habit of transformation. (BRAZIL, 2013, p. 1).

The Brazilian Air Force (FAB), in line with its transformation and with its eyes on the future, has modernized itself and has issued Strategic Design Air Force 100, DCA 11-45[2] (BRAZIL, 2017), which reaffirms its commitment to the personnel preparation and qualification.

> An effective weapon system operated by skilled personnel and with an innovative point of view is a very powerful set. FAB should be able to modernize its training and specialization techniques while preserving the standards and discipline necessary to achieve the effectiveness identified in FAB's vision for the future. (BRAZIL, 2017, p. 32).

The training and operational maintenance of the FAB F-5M pilots are defined by the Preparation Command (COMPREP) through their Preparation Guidelines (DIPREP) that define the operational minima to be fulfilled by the pilots in the course of a year in the several missions applicable to the F-5M. Another guiding document is the Operational Maintenance Program (PIMO), a document issued by ALA[3] to which the Air Squadron is subordinate, and which defines how each Squadron will use its air effort in order to keep its pilots trained.

The guidelines and the PIMO determine the missions that will be trained in order to keep the skills of the pilots up to date, but they do not define the regularity or a maximum time limit between trainings. In aviation jargon, when the pilot stays for a long period without flying, he undergoes a new training called **readaptation**, in order for the pilot to reacquire the abilities degraded by the time away from flying. The DIPREP establish the readaptation programs to be carried out in case of total removal from the airborne activity, but do not define the maximum removal time by type of mission.

The United States Air Force (USAF) establishes the loss of adaptation and consequent loss of proficiency for several types of missions, separating pilots into expert and inexperienced. Based on the typical fighter mission, the Visual Airborne Combat (Within Visual Range - WVR), an expert US pilot on the F-16 aircraft loses proficiency by snot flying this mission for more than 90 days, according to Air Force Instruction (AFI) 11-2F-16V1 - F-16 Pilot Training (UNITED STATES OF AMERICA, 2015). The other USAF fighter aircrafts use the same parameters.

[2] DCA: Directive of the Air Force Command.

[3] ALA: Organization of the Preparation Command (COMPREP) to which the Air Squadron is subordinate.

The author, during his operational life, witnessed pilots who returned to fly a certain mission after long time away and, in those occasions, these pilots commented the forgetfulness or the difficulty in executing procedures. These failures can be considered as the degradation of a previously existing skill, since it is understood as the skill the

> ability to put knowledge into action to generate results, mastery of techniques, talents, abilities - EXPERTISE. (GRAMIGNA, 2007, p. 50).

Based on these observations, we sought to study the influence of air activity removal on the performance of the F-5M pilot. This condition led to the present research problem: to what extent the removal longer than 90 days influences the performance of expert pilots of the F-5M aircraft in airborne visual combat missions?

When analyzing human performance, it inevitably refers to ergonomics, which is the scientific discipline concerned with understanding the interactions between human beings and other elements of the system, and the profession that applies theories, principles, data and methods to projects in order to optimize human well-being and overall system performance (DUL; WEERDMEESTER, 2008). Ergonomics has three domains: physical ergonomics (human anatomy features), cognitive (mental processes such as: perception, reasoning, memory and motor response) and organizational (optimization of structures, policies and processes).

The analysis on the subject fell on the cognitive and organizational domains of ergonomics. However, it can also be verified that physical ergonomics is linked to the performance of the fighter pilot and may also be affected by the frequency of the training, but that was not the object of study of this work.

With a view to the delimitation of the research, only expert pilots of the Squadrons that have a similar reality were analyzed: 1st GAvCa, 1st/14th GAV and 1st GDA. Since the FAB does not classify its pilots as experts or inexperienced, the USAF standardization established in AFI-11-412 - Aircrew Management was adopted, whereby the pilots who have 500 hours in the aircraft (UNITED STATES OF AMERICA, 2009a) or pilots that have 100 hours in the aircraft, but have already reached the mark of expert in another fighter aircraft, as explained by Bigelow et al. (2003), are therefore considered experts.

To conduct the research, two guiding questions were defined: a) what skills are needed for the F-5M pilot in visual airborne combat missions ?; and b) what abilities are affected when an expert F-5M pilot is away for more than 90 days from airborne visual combat missions?

Thus, it was aimed to assess to what extent the removal longer than 90 days influences the performance of expert pilots of the F-5M aircraft in airborne visual combat missions.

Specific objectives are: a) to identify the necessary skills for the F-5M pilot in the visual airborne combat missions; and b) identify the skills that are affected when an expert F-5M pilot remains away for more than 90 days of airborne visual combat missions.

Although the research is restricted to F-5M pilots, it is expected that it will serve as a reference to support future decisions about the frequency of fighter pilot training and the consequent maintenance of the skills obtained in the initial formations. The F-39[4] will bring several technological innovations to Brazilian Fighter Aviation, however, the human material that will provide the nacelle will maintain its characteristics, which, if well exploited, will form the powerful desired set of the Strategic Air Force 100 (BRAZIL, 2017).

2 THEORETICAL FRAMEWORK

The theoretical basis of this work was on studies by Stillon (1999) and Mager and Pipe (1979).

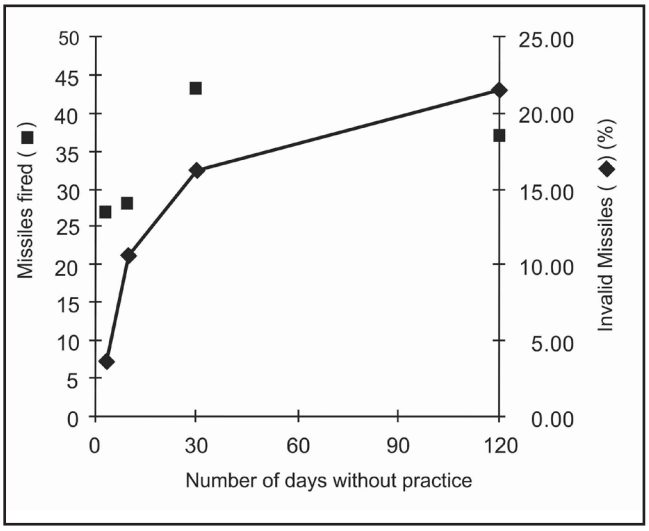
The concern with the maintenance of the prepare and the fighters' abilities, especially of the fighter pilots, is not a Brazilian peculiarity. Other air forces in the world have the same concern. Stillon (1999) studied the impact of the lack of training on the performance of the USAF fighter pilot. Regarding airborne combat, he emphasized its complexity, considering one of the missions that demand greater engagement of the pilot in cognitive and physical tasks.

In his study, 137 shots of simulated missiles of the F-16 aircraft were analyzed. From these, 19 were invalidated by procedural errors. Stillon (1999) sought to check the relationship between the number of expert pilots and the recent practice. His survey was limited to analyzing the quality of the shot, not taking into account the other skills of the pilot in this type of mission.

When analyzing the shots, he found that pilots who had used missiles in the last 10 days had a hit rate of 93%, while pilots who had used missiles for more than 90 days had a hit rate of less than 80%, as shown in Figure 1. He draw a conclusion that [...] the performance of airborne combat skills are more dependent on frequency and regularity than on experience [...] (STILLON, 1999, p. 84, own translation).

[4] F-39: fighter aircraft under development in Sweden, called Gripen NG. It was acquired by Brazil through the FX-2 program. This aircraft will replace the F-5M aircraft at FAB.

Figure 1 – Number and percentage of invalid missiles according to the number of days without practice.



Source: Stillon (1999, p. 83, own translation).

The authors Mager and Pipe (1979) address the theme from the point of view of human performance, reinforcing the conclusions of Stillon (1999) that, "The more critical the skill, the more important the practice is provided" (MAGER, PIPE, 1979, 32).

Although fighter pilots are very demanding in their training, it is often difficult to follow the technological advances, as new aircraft technologies become increasingly complex day by day. The impact of this complexity is felt directly by the pilot who will have to manage all these new features, modes and options in a variety of operational circumstances (WOODS; SARTER, 1998). In this context, the pilot becomes the weakest link in the process. From the perspective of organizational ergonomics, the adoption of some optimization is necessary, and Mager and Pipe (1979: 39) propose an institutional attitude.

> The more complex the task, or the more critical, i. e., the more requirements are regarding accuracy of performance, the more motivation we will have to offer an aid rather than simply expect people to be "very well trained." If you have a role that is performed infrequently and is critical at the same time, you have every reason to look for ways to reduce the need to use human skills such as memory and judgment.

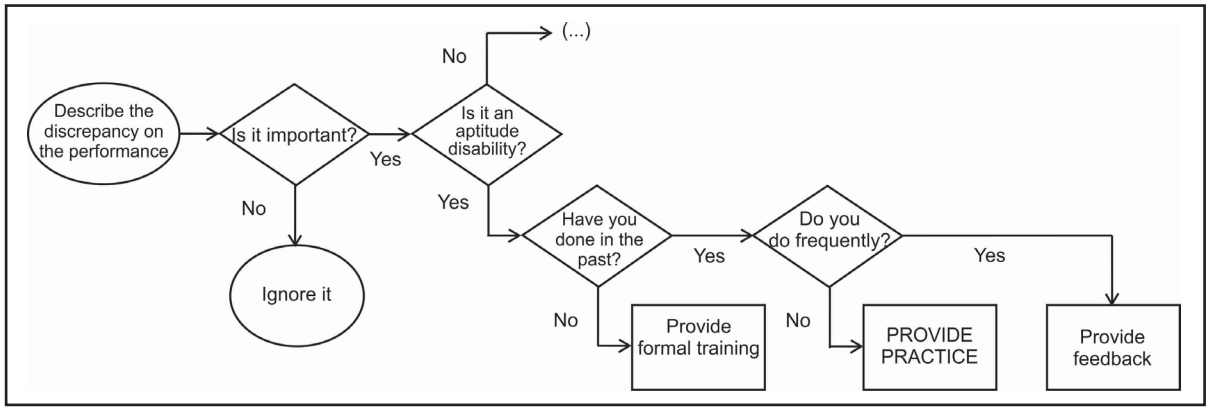
The authors propose a systematic, through questions, that seeks to find solutions to performance problems, according to Figure 2.

This research used the flowchart shown in Figure 2, answering the questions proposed. In other words, initially it was identified if there was a discrepancy in the performance of pilots who were away for more than 90 days from the visual combat missions. Pilots who found themselves in this situation stated performance discrepancies.

The USAF (UNITED STATES OF AMERICA, 2015) uses 90 days of removal from WVR missions as a benchmark to provide new practice to its pilots. Stillon (1999) pointed out that the lack of frequency is preponderant and that pilots who were removed for more than 90 days showed discrepancies higher than 20%. By setting this time reference, the research sought to reach its goal of identifying to what extent the removal over 90 days influences the performance of F-5M aircraft expert pilots in airborne visual combat missions.

When identifying skill discrepancies, the answer was yes to the next three questions in the flow. Is it important? Yes, since it is an expected ability of the F-5M pilot. Is it an aptitude disability? For Mager and Pipe (1979), a practical way to identify if is an aptitude disability is to question whether it would occur it if the person's life depended on that skill. If he/she still could not perform, it is because of an aptitude disability. Once the fighter pilot is trained for the conflict, it is understood that he/she will fight as he/she trains. Finally, since the research universe was composed of experienced pilots, therefore the pilot has already performed those actions in the past..

Figure 2 – Flowchart to find solutions to performance problems.



Source: Adapted from Mager and Pipe (1979, p. 3).

What would lead to the last question regarding to the frequency of training. Once the research reached that point in the flow, it reaffirmed the consistency of the training frequency adopted by the USAF (UNITED STATES OF AMERICA, 2015) and observed by Stillon (1999). It can be seen, therefore, that the removal of airborne activity influences the performance.

In order to assess to what extent this influence occurs, the pilot skills division for the tactical use adopted by the USAF (UNITED STATES OF AMERICA, 2009b) and by Bigelow et al(2003) was used as analysis categories. Both referential divide skills into general and specific air-to-air. General skills are common to several missions performed by the aircraft, such as visual or radar search, which is useful for interception and WVR combat flights. Air-air skills, on the other hand, are those performed exclusively in this type of mission.

3 METHODOLOGY

Based on the general objective, a descriptive research (GIL, 2002) was carried out to identify the relationship between the variables **removal over 90 days and the performance of F-5M expert pilots in airborne visual combat missions.**

As for the technical procedures for data collection, the research was characterized by the direct interrogation of the people whose behavior was relevant for this study, in this case, the F-5M expert pilots. Survey research was chosen because of its advantages in providing direct knowledge of reality, economy and speed and quantification. These factors were explored in the course of the study.

Initially, the results found by Fórneas (2015) were analyzed, which sought to identify, by the Delphi method, the skills required for the F-5M operational pilot. To determine these abilities, the author conducted two rounds of the Delphi method with 10 aircraft specialists and the Fighter Aviation. In the first round, all competences were identified; in the second, the consensus among the specialists was verified. The F-5M instructors who had more than 500 hours in the aircraft or participated in at least two international maneuvers such as Red Flag[5], SALITRE [6] or CRUZEX[7] and flown with Head Mounted Display (HMD)[8] in an integrated manner with the Python IV[9] missile in operational missions were considered as experts.

In order to delimit the research sample, the Heads of the Statistical Section of the 1st GAVCA, 1st/14th GAV and 1st GDA were consulted to identify which pilots of these Squadrons had the criteria to be considered experienced and who were removed from WVR missions, in the function of 1P[10], for a period longer than 90 days in the years of 2016 and 2017, excluding the author. The period was adopted by the similarity in the number of flight hours distributed to each pilot, thus obtaining the same basic characteristics of the population regarding the phenomenon researched (CORREA, 2003). This consultation identified 39 F-5M pilots that fit the established requirements.

Then, the questionnaire was used as a data collection tool (GIL, 2002), composed of structured questions with the objective of identifying, in the cognitive ergonomics domain, if any of the 25 skills are degraded when the F-5M expert pilot is away more than 90 days in the WVR missions. The questionnaire is original and was based on responses of five points on the scale proposed by Likert (1932). In order to verify their integrity and consistency, the questionnaire was pre-tested on F-5M expert pilots not present in the sampled set and was subsequently submitted to the 39 pilots previously identified (GÜNTHER, 2003).

As an introductory question; the answerer's experience was questioned, which was divided into three lanes: pilots with experience between 100 and 250 hours on the F-5M aircraft, between 250 and 500 hours, and with more than 500 hours. This approach aimed to identify if the experience of the pilot in the aircraft changes his/her perception regarding the influence of the removal. Thus, it was tried to compare if the findings that the frequency of training in airborne combat is more determinant than the experience (STILLON, 1999) are also applicable to the Brazilian reality.

The three Squadrons studied have in total a universe of 60 pilots, among them, pilots under training and pilots who maintained frequency of training less than the 90 stipulated days. Thus, the inductive method was applied, using the data of the sample of 39 pilots, inferring the result to the universe of 60 F-5M pilots of the three Squadrons. A minimum desired sample of 33 respondents was considered for a 90% degree of reliability, with a 10% margin of error, as established by Cochran (1965).

[5] Red Flag: multinational operational exercise organized by the USAF.
[6] SALITRE: multinational operational exercise organized by the Chilean Air Force.
[7] CRUZEX: multinational operational exercise organized by FAB.
[8] HMD: helmet with the ability to project information for the pilot, including missile aiming.
[9] *Python* IV: 4th generation infrared missile manufactured by the Israeli company Rafael.
[10] 1P: first pilot.

As discussed earlier, a WVR combat flight is complex and quantifying pilot performance is more difficult than in other mission types (STILLON, 1999). This was a limitation of the research, since the complexity and performance degradation of the pilots would only be truly verified with the accomplishment of numerous flights and immediate data collection. Thus, given the time and available resources, this research sought, through the questionnaire applied, to capture the pilot's perception and agreement regarding the degradation of abilities that are directly related to the performance of this pilot, according to Hart and Staveland (1988).

> Subjective experiences extend beyond their association with subjective classifications. The phenomenological experiences of human operators affect subsequent behaviors and therefore affect their performance and physiological responses to a situation. (HART; STAVELAND, 1988, p. 3).

With the data collected, an assessment was made of the agreement of the researched universe for each skill. Tables, charts and descriptive statistics were used as analysis procedures, with the use of median, showing appropriate techniques for a Likert scale (GÜNTHER, 2003). After the assessment of each skill, the assessment was performed by analysis category: general skills and air-to-air skills. Thus, it was intended to reach the answer of the research question and, consequently, to reach the proposed objective for this scientific project.

4 DATA PRESENTATION AND ANALYSIS

As a result of the analysis of the Fórneas (2015) studies, 25 skills were identified for the F-5M pilot in the WVR combat missions, presented in Table 1.

In order to facilitate analysis, these 25 skills were divided into two subgroups of pilot skills for tactical use, as predicted by the USAF (UNITED STATES OF AMERICA, 2009b) and Bigelow et al. (2003). This division resulted in 12 skills considered as general and 13 skills as specific to the air-air missions as Table 1 shows.

Table 1 – Skills required for the F-5M pilot in visual combat missions divided into tactical use skills: general and air-to-air. Tactical: general and air-to-air.

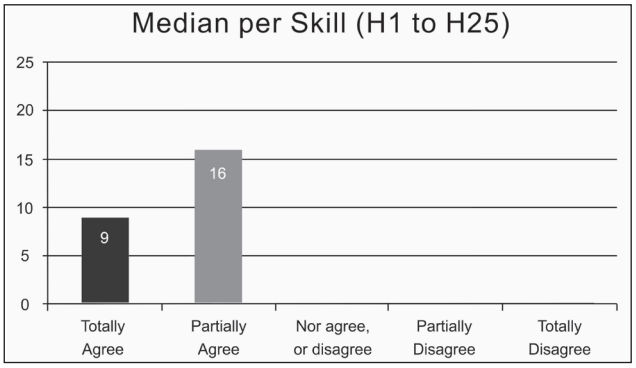
Skills for Tactical Use	
General skills	Air-to-air missions skills
H1 - Select the appropriate weaponry for the situation?	H2 - Use of Python-4 missile in the three enslavements (boresight, RDR and HMD)?
H6 - Manage multiple systems simultaneously (aircraft, radar, weaponry, fuel, HMD, etc.)?	H3 - Use of Python-3 missile in the three enslavements (boresight, RDR and HMD)?
H7 - Perform the enslaved radar search to the HMD (ACM boresight)?	H4 - Use the Derby missile in a WVR arena - within visual range (LOBL - Lock-on Before Launch) exploring its short range characteristics?
H8 - Using the Air combat modes (ACM) correctly when in the dogfight submode?	H5 - Use of aircraft barrel weaponry (20mm cannon)?
H11 - Operate the aircraft's HOTS (Hands On Throttle And Stick) system (flight commands, weaponry, RDR, HMD and EW)?	H9 - Perform side-throwing of Python-4 using enslavement in HMD?
H13 - Perform the defenses working with the engine (IRCM)?	H10 - Use the radar enslavement of the missiles when the situation requires?
H14 - Correctly use countermeasures (Chaff/Flare) whenever there is an infrared missile threat	H12 - Maneuver your aircraft to position yourself in position to use the weaponry in the shortest possible time?
H16 - Use airborne radar in air-to-air modes (interception and dogfight)?	H15 - Perform interception profiles, interception geometry to maximize the advantage in visual combat (1-turn tactic, with launch before crossing)?
H17 - Using HMD in air-to-air modes (intercept and dogfight)?	H18 - Coordinate the work of your pair managing the position of the wing?
H19 - Maintain a high situational awareness with respect to threats?	H21 - Perform the basic and advanced visual combat maneuvers correctly?
H20 - Perform good visual search technique?	H23 - Use combat phraseology correctly?
H22 - Maneuver the aircraft according to the RWR interpretation?	H24 - Apply free fighter and support functions correctly?
	H25 - Use the radar mode to obtain RDR contact and the use of weaponry correctly?

Source: Adapted from Fórneas (2015, p. 28).

With these skills, the questionnaire was prepared, which, after being pre-tested, was sent to the 39 pilots in the sample, and 38 answers were received. Thus, it can be induced that the answers obtained are applicable to the universe of 60 pilots of the three Squadrons studied, with 95% of confidence and 10% of error margin (COCHRAN, 1965).

According to the perception of the studied pilots, the 25 skills required for the F-5M pilot in the WVR missions were deemed degraded due to the absence of airborne activity for more than 90 days. Nine of them (36%) showed a degree of Completely Agree and 16 of them (64%) a degree of **Partially Agree**. No median (0%) showed a degree of **nor agree**, **nor disagree**, **partially disagree** and **totally disagree**, as shown in Figure 3. **Not observed** answers were disregarded and did not influence the analysis, as indicated by Günther (2003).

Figure 3 – Resultados das medianas por habilidade.



Source: The author.

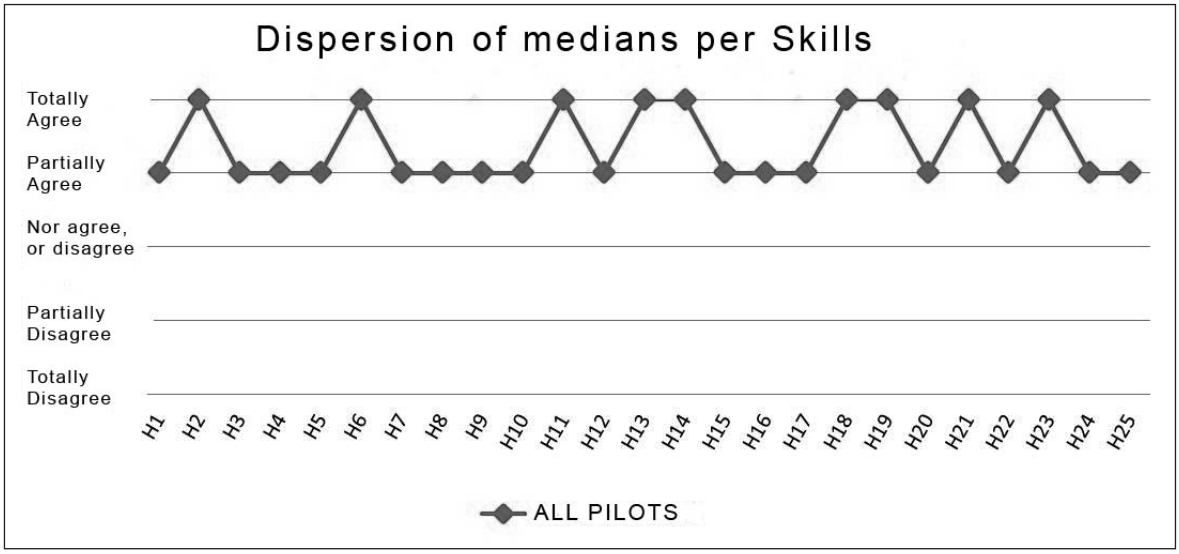
Analyzing each skill separately, the result was found, according to Figure 4. This led us to conclude what abilities are affected when an F-5M expert pilot is away for more than 90 days from visual airborne combat missions.

Considering that all skills were somewhat degraded, yes was answered for the first four questions in the flowchart proposed by Mager and Pipe (1979). a) Describe the performance discrepancy. The initial perception that motivated the research was reaffirmed by the agreement of the respondents. b) Is it important? Yes, because it is an expected skill for an F-5M pilot. c) Is it an aptitude disability? Yes, because the pilot will fight as he/she trains. d) Have you done it in the past? Yes, because the sample is composed of experienced pilots.

Once the research established the scenario of 90 days of air activity removal and asked only pilots who had experienced this situation, the fifth question, how often do yoy perform?, had no as an answer as shown in Figure 5. Thus, the maximum training removal adopted by the USAF (UNITED STATES OF AMERICA, 2015) and the degradation of performance due to the removal found by Stillon (1999) were also consistent in the Brazilian squads surveyed.

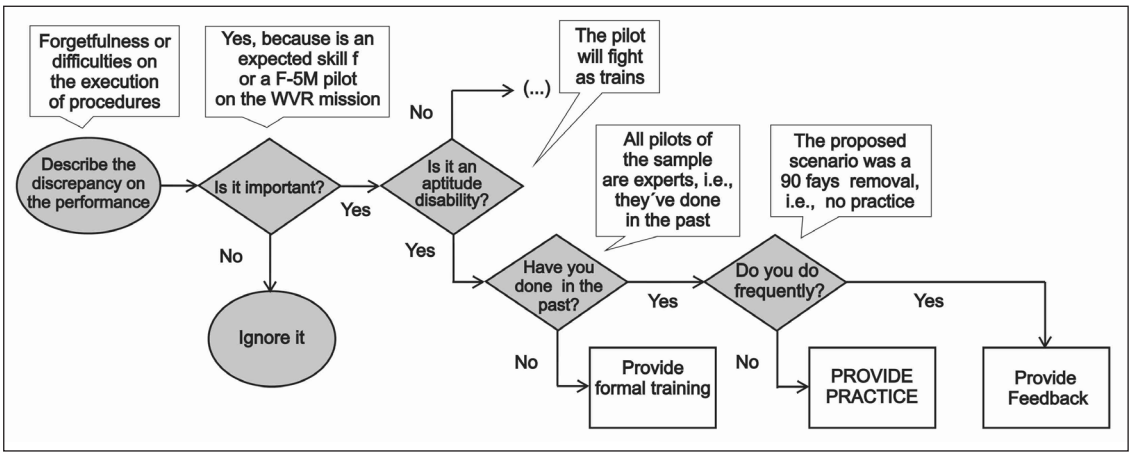
Focusing on assessing to what extent the removal influenced the performance of pilots, the median found for each skill was analyzed according to the division by category of analysis presented above, in other words, divided into general and air-to-air skills (UNITED STATES OF AMERICA, 2009b BIGELOW et al., 2003).

Figure 4 – Agreement on abilities degraded by removal longer than 90 days.



Source: The author.

Figure 5 – Answers found for the flowchart of solutions to performance problems.



Source: Adapted from Mager and Pipe (1979, p. 3).

Regarding the general skills, five of the 12 were considered degraded with a degree of **Totally Agree**. In turn, the air-to-air skills had four of the 13 with a degree of T**otally Agree**. These results reflect the degradation of performance against the time of removal, according to Table 2.

Table 2 – Results of medians divided by Skills for Tactical Use.

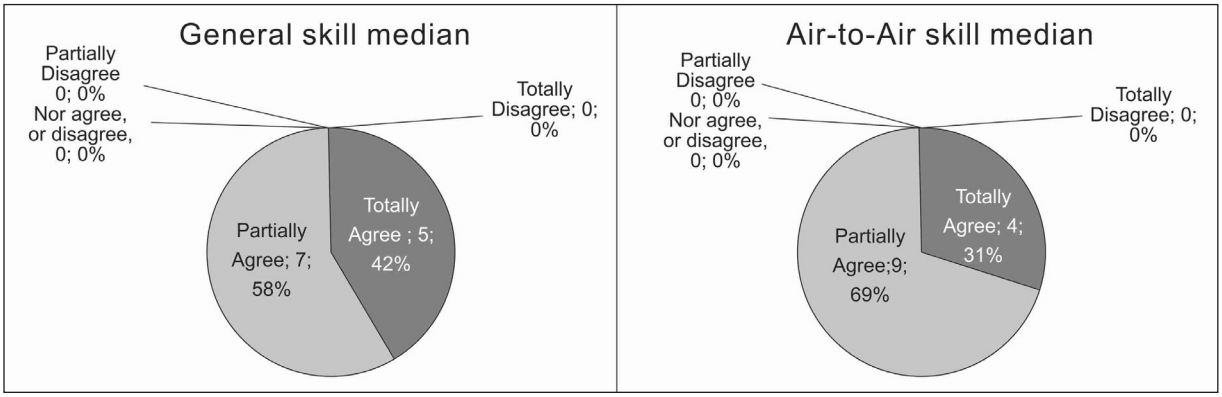
Median Results	Skills for Tactical Use	
	General Skills	Air-to-air missions kills
Totally Agree	H6, H11, H13, H14 and H19.	H2, H18, H21 and H23.
Partially Agree	H1, H7, H8, H16, H17, H2O and H22.	H3, H4, H5, H9, H10, H12, H15, H24 and H25.

Source: The author.

The data presented previously, when analyzed in percentile, are represented in Figure 6. It is noticed that the general skills presented 42% of agreement with a degree of **Totally Agree** and the air-to-air abilities showed 31% in the same aspect. Although there is a difference in the degree of agreement, when the skills are divided by categories, it is small and insignificant difference. However, a significant difference was observed when 100% of the results showed that the removal time factor is a determinant of performance degradation, regardless of skill type or classification.

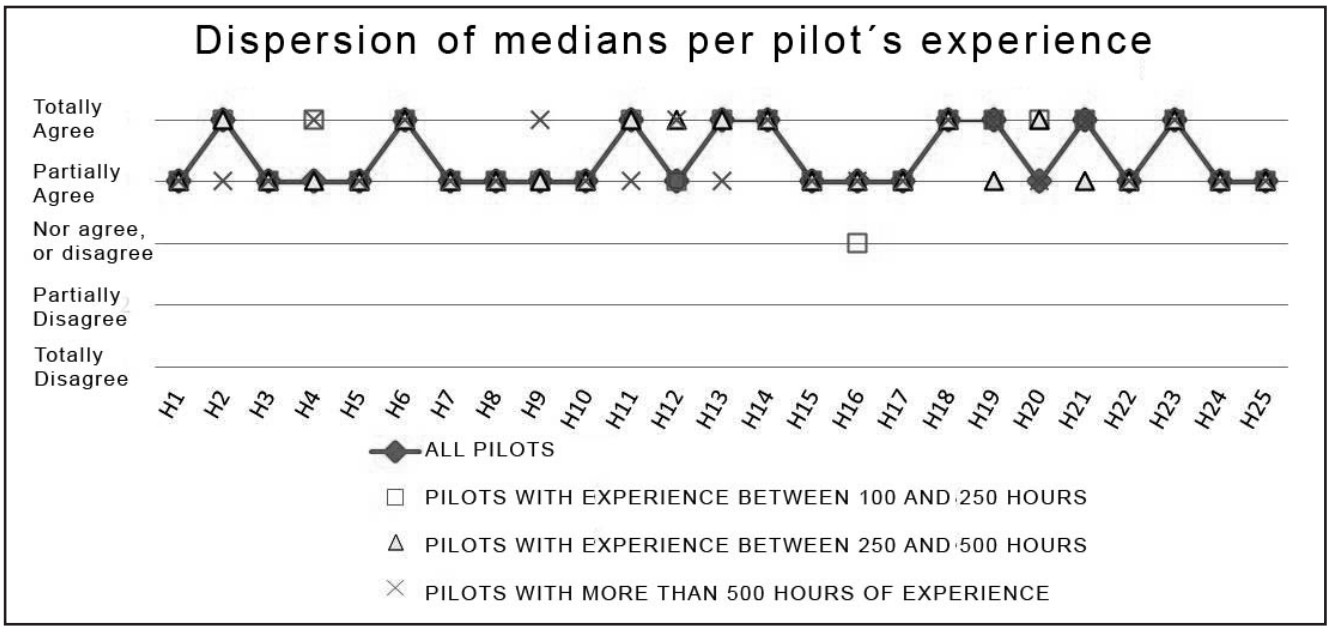
The answers received were separated by experience levels of the interviewed and their respective medians were compiled. In this separation, three lanes were considered: pilots with experience in the F-5M aircraft, between 100 and 250 hours, between 250 and 500 hours and with more than 500 hours. When analyzing them, it is noticed that, regardless of the experience of the respondents, the dispersion of the medians is minimal, being mostly similar to the response of the sample, according to Figure 7. This finding reaffirms what has been found in studies in the USAF in which air combat performance is more dependent on frequency and regularity of training than on experience (STILLON, 1999).

Figure 6 – Graph of medians by general skills and air-to-air skills.



Source: The author.

Figure 7 – Dispersion of medians by pilots' experience.



Source: The author(2017).

Thus, according to the general objective of this work, to assess to what extent the removal longer than 90 days influences the performance of expert pilots of the F-5M aircraft in airborne combat missions, it was observed that 100% of the abilities are degraded in function of the removal time; being 36% **Totally Agree** and 64% P**artially Agree**, when viewed globally. When categorized, general skills are observed, 42% **Totally Agree** and 58% **Partially Agree** and; in air-to-air skills, 31% **Totally Agree** and 69% **Partially Agree**.

5 CONCLUSION

Armed Forces prepared and in conditions to be ready for combat is the desire of the National Strategy of Defense and, consequently, of the Brazilian Air Force. Thus, every FAB F-5M Air Squadron seeks to maintain the most appropriate training for its pilots every year.

This current work sought to assess what extent the removal longer than 90 days influences the performance of expert pilots of the F-5M aircraft in airborne visual combat missions. In order to do so, we first identified 25 skills necessary for the F-5M pilot in visual airborne combat missions (FÓRNEAS, 2015). In a second moment, 39 pilots of three FAB´s F-5M Squadrons who remained more than 90 days without flying in WVR combat in the years of 2016 and 2017, received a five-point questionnaire on the Linkert scale (1932). The questionnaire helped in identifying which skills were affected when the pilot was removed more than 90 days from the WVR missions.

The research had as limitation the complexity in quantifying the performance of pilots in WVR combat flights. Given the time and resources available, this research sought, through the applied questionnaire, to capture the pilot's perception and agreement regarding the degradation of abilities that are directly related to the performance of this pilot.

As a theoretical basis, we used the studies by Mager and Pipe (1979), which established a flowchart for the analysis of performance problems, and Stillon (1999), who realized that the lack of periodicity of training is directly related to the degradation of performance of fighter pilots, being even more decisive than the experience.

The skills were analyzed as a whole and separated into two categories: general skills and air-to-air (BIGELOW et al., 2003). The pilots, in turn, were analyzed in groups and separated by levels of experience.

As a result of this research, it was identified that 100% of the abilities are degraded by the removal for more than 90 days; being 36% **Totally Agree** and 64% **Partially Agree**, when viewed globally. When categorized, general skills are observed with 42% **Totally Agree** and 58% **Partially Agree** and;

in air-to-air skills, 31% **Totally Agree** and 69% **Partially Agree**.

When evaluating the answers, it was observed that the pilots' experience did not influence the perception of skill loss, reaffirming the findings identified by Stillon (1999).

The results obtained pointed out the need to review the removal limits of the WVR mission training for FAB F-5M pilots. The period of removal stipulated in this study was the same as that adopted by the USAF, which uses 90 days as the maximum removal limit. In the air force in question, when this limit is reached, the pilot must do a rehabilitation mission to visual combat to regain the skills expected.

The identification of the degradation of the performance due to the removal, analyzed by this work, will serve as scientific basis to support future decisions about the frequency of the training of fighter pilots and the consequent maintenance of the abilities obtained in the initial formations. The conclusions, as they affect the performance of the fighter pilots, will be useful also in the formulation of the training program of the new FAB fighter, the F-39 - Gripen.

This work was focused on the performance of F-5M pilots in airborne visual combat missions. However, the USAF (UNITED STATES OF AMERICA, 2015) has removal periods and rehabilitation programs for its pilots on numerous other missions, which leaves open the way for further work to see if the removal of airborne activity affects skills of pilots on other missions as well.

Another field of study left open was about the impact of the removal of the airborne activity on the performance of the pilots when analyzed from the perspective of the physical ergonomics.

This work aimed at promoting an assessment of the influence of air activity removal on the performance of F-5M pilots, explaining that there is a degradation of skills due to lack of practice, and provides a scientific basis for the improvement of training of fighter pilots, aiming, therefore, an Air Force becoming each day more prepared and ready for the defense.

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