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REVIEW ARTICLE

THE RELEVANCE OF NEUROTICISM IN FLIGHT TRAINING FOR JET AIRCRAFT PILOTS

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Introduction: This study investigates the role of neuroticism in the performance of military pilot candidates, with a focus on its influence on flight training success. Specifically, it explores whether neuroticism can be a predictor of training outcomes, particularly for those selected for advanced fighter aircraft training, such as the F-16.

Methods: The analysis encompassed the data of 22 pilot candidates, among whom 10 were selected for F-16 training, while the remaining 12 were assigned to training on other aircraft types. Neuroticism scores were assessed using psychological tests (NEO-FFI and NEO-PI-R) administered prior to training, and subgroup comparisons were conducted to evaluate the relationship between neuroticism and training performance.

Results: Although the overall level of neuroticism was low in all participants (M = 4.2; SD = 1.1 on a 9-point scale), subgroup comparisons showed that candidates designated for F-16 training had relatively higher neuroticism scores (M = 4.6; SD = 1.0) than those who were assigned to other aircraft training (M = 3.9; SD = 1.2). The difference in total neuroticism score was not statistically significant ($t(20) = 1.45$, $p = .163$). Still, specific facets—such as anxiety and self-consciousness—showed medium effect sizes (Cohen's $d = 0.5–0.6$), suggesting potential practical relevance despite the lack of statistical significance.

Discussion and Conclusions: The results suggest that while neuroticism may play a role in differentiating between subgroups, its influence on selection for F-16 training appears to be multifaceted. The findings highlight the need for further investigation to determine which specific aspects of neuroticism—such as emotional regulation, anxiety, or impulsivity—are most relevant for success in advanced fighter pilot training. These insights may contribute to refining pilot selection processes and enhancing training outcomes.

Keywords: personality, neuroticism, jet pilots, flight training

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INTRODUCTION

In aviation studies, personality traits are considered both during the pre-selection of candidates and in evaluating their aptitude for successful performance in demanding aviation environments. Research on pilot personality offers valuable insights into which traits influence training effectiveness, the ability to manage pressure, decision-making in crisis situations, and overall flight operation safety [2].

In the selection and assessment of pilot candidates, emotional stability emerges as a key predictor of performance in high-stress environments. Notably, a low level of neuroticism, often linked to high emotional stability, is considered desirable as it correlates with better stress management and more accurate decision-making in challenging situations [14]. Conversely, some studies suggest that an average level of neuroticism in certain groups of pilots may be associated with heightened risk awareness and a more reflective approach to challenging situations. Furthermore, extraversion, as a personality trait that enhances effective communication, crew cooperation, and adaptability in dynamic conditions, has been shown to positively influence success in flight training [3]. Additionally, traits such as agreeableness and conscientiousness have been demonstrated to impact a pilot's ability to cooperate with other crew members and work effectively in a team [6].

An important challenge in the selection process and psychological assessment is accounting for the differences arising from the specific requirements of various aircraft types. It can be assumed that traits related to communication and group task coordination will be more critical for operating in a multi-person crew than when piloting high-wing aircraft. On the other hand, traits related to the need for stimulation and resistance to stress may be crucial for effective performance in combat aircraft. In training on fighter aircraft, such as the F-16, traits like a propensity for competition, confrontation, and mental toughness may play a more significant role than in training on aircraft with different operational characteristics. Similarly, differences in workload across various types of aircraft may highlight the need to consider variations in personality traits. This conclusion can be indirectly supported by the work of Biernacki and Lewkowicz, who found that pilots of high-wing aircraft rated their mental performance and workload as significantly higher than pilots of other transport aircraft and helicopter pilots [5].

Among the range of personality traits, neuroticism is undoubtedly one of the key factors. It is one of the few traits for which a high level is crucial for adaptation and response during flight operations. In personality research, neuroticism is one of the five major traits within the widely recognized Big Five model, alongside extraversion, openness to experience, agreeableness, and conscientiousness. Neuroticism refers to an individual's propensity to experience negative emotions, such as anxiety, worry, anger, or sadness. Highly neurotic individuals are also more susceptible to stress and may exhibit difficulties in regulating emotions in demanding situations. Conversely, low neuroticism, often equated with high emotional stability, is associated with greater psychological resilience and composure in the face of adversity. In the context of military aviation candidate selection, understanding the role of neuroticism can be of significant importance, as stress resilience and effective emotional management are crucial in an environment characterized by high psychophysical demands. The significance of neuroticism in pilot research has been the focus of numerous studies, particularly due to its impact on the ability to cope with stress, decision-making in crisis situations, and overall performance under high psychological pressure. This finding is aligned with the results of a meta-analysis examining 26 studies on the role of personality traits in predicting outcomes of military flight training [3]. Among the traits analyzed, neuroticism (K = 7), extraversion (K = 8), and anxiety (K = 4) were most frequently identified as significant predictors. Using a random-effects model, the analysis revealed a negative mean effect for neuroticism (rmeta=−0.15) and anxiety (rmeta=−0.11), while extraversion had a positive mean effect (rmeta=0.13). When adjustments were made for predictor reliability and range restriction, neuroticism exhibited the highest corrected accuracy coefficient (rcorr=−0.25), indicating that enhancements in measurement tools could further improve predictive precision. These findings substantiate the hypothesis that neuroticism and its anxiety component detrimentally influence training outcomes, whereas extraversion contributes positively to training success [5,12].

Research on the role of neuroticism in pilots indicates that low levels of this personality trait are crucial for effective performance in stressful, high-pressure, and team-oriented conditions. Chidester et al. [7] demonstrated that pilots with low neuroticism perform better in crisis situations, such as aircraft emergencies, due to their superior emotional regulation and concentration. Martinussen and Hunter [13] further emphasized that low neuroticism is important for emotional control and

resilience to stress, while high neuroticism can lead to overstimulation, hindering accurate decision-making [13]. It is supported by the fact that pilots with high neuroticism are more likely to make errors in simulated emergency situations, particularly under time pressure. Additionally, high levels of neuroticism are associated with greater susceptibility to fatigue and burnout [11]. This may be due to the fact that pilots with higher neuroticism are more sensitive to environmental stressors, such as changes in flight schedules, adverse weather conditions, or time pressure, which can lead to chronic fatigue and job burnout [15].

Moreover, several studies demonstrated that, in high-stress situations, pilots with higher levels of neuroticism struggle with processing information, decision-making, and attention management, whereas those with lower levels of neuroticism excel in complex cognitive tasks. Another domain where low neuroticism is critical is team cooperation [5,9]. Bartram et al. found that pilots with high neuroticism are more prone to interpersonal conflicts, which can impede effective teamwork [2]. In the cockpit of an aircraft, where cooperation and communication are paramount, low neuroticism significantly enhances operational effectiveness [7,10]. Among studies on military pilots, the work of Picano et al. is particularly noteworthy [17]. Their findings indicate that low neuroticism predicts success in intensive combat training for fighter pilots, whereas higher neuroticism is associated with greater difficulty in adapting to stressful conditions. This observation can be attributed to the association between neuroticism and impulsive behavior, which may lead to hasty and unreflective decisions. In the cockpit of an aircraft, where cooperation and communication are paramount, low neuroticism significantly enhances operational effectiveness [7,10]. In summary, a low level of neuroticism is a reliable predictor of pilot success and a critical factor in promoting flight safety, crisis management effectiveness, cognitive performance, and team collaboration.

Introduction to the Issue of Own Research

In the context of Polish military aviation, individuals aspiring to become pilots are required to undergo a rigorous medical and psychological evaluation process before being admitted to the prestigious Polish Air Force University. In 2008, the Military Institute of Aviation Medicine introduced a modified test battery, adapted to contemporary standards, for the psychological evaluation of candidates. This test battery has since been used in a largely unchanged form. In 2013, the first cohort of candidates tested with this contemporary battery successfully completed their flight training. Within this group of 22, a subset of the top 10 candidates was identified by the instructors, who, based on their high marks, recommended them for further training on F-16 aircraft. Although the primary purpose of the candidate screening was to identify individuals with high aptitude in areas relevant to the pilot profession, such as spatial abilities and psychomotor coordination, the process also included a personality profile assessment [1,6]. This assessment aimed to exclude traits that could significantly hinder performance both as a pilot and in the military environment in general [8]. Upon completion of flight training, we decided to investigate the extent to which personality traits in this selected group might have predicted their progress during training. To achieve this, we compared the overall final instructor evaluations with the test results obtained during their initial assessment.

As highlighted in the introduction, the dimensions of Neuroticism and Extraversion are among the most frequently analyzed in the literature and show significant relationships with training progress [5]. In the group we analyzed, however, the relationship between Extraversion, as measured by the NEO-FFI questionnaire [18], was not statistically significant ($p = 0.29$). In contrast, Neuroticism was found to be significantly and positively correlated with instructor ratings; that is, those who received higher ratings from their instructors scored relatively higher on this scale. Neuroticism, and its associated trait of emotional stability, is a crucial factor related to pilot performance [9,16]. This influence is most evident in high-pressure situations. A low level of neuroticism in a pilot is indicative of an individual who, under life-threatening conditions, exhibits a high level of mental resilience, which facilitates making accurate judgments and quick decisions within a limited timeframe (citation needed). However, it should be emphasized that the results of self-report tests used in selection situations are often highly distorted and should be interpreted with caution, as they may not accurately reflect the true level of the measured traits in the subjects. It is well-established that, in selection contexts, individuals tend to engage in impression management, selectively choosing 'correct' responses to present themselves favorably. Additionally, the high homogeneity of personality traits within the pilot group further diminishes the predictive value of such indicators. The minimal variance in self-report scale results, which is also evident in the analyzed group across all NEO-FFI

scales, typically renders it nearly impossible to assess the relationship between these dimensions and actual progress in flight training.

For the reasons mentioned above, the non-intuitive and, contrary to previous literature, statistically significant positive association between Neuroticism and instructor ratings was considered worthy of further investigation. To verify this effect, after the abovementioned group of participants completed their training, they were re-assessed using the NEO-PI-R questionnaire (Polish adaptation) as part of a periodic psychological evaluation. This additional survey aimed to determine whether the observed effect would hold in a different context—one that was temporally distant and not directly related to the initial selection process. The NEO-PI-R questionnaire also provided an opportunity to explore which Neuroticism facets, if the effect is confirmed, are most strongly associated with training progress.

In light of the exploratory nature of these findings and in order to guide our further analysis, we formulated the following research questions:

1) To what extent is the level of neuroticism assessed during the initial selection phase a predictor of success in flight training, particularly among candidates for high-performance aircraft (F-16)?
2) Does the facet profile of neuroticism differentiate those recommended for F-16 training from individuals with lower performance outcomes in training?

These questions reflect our attempt to better understand the nuanced role of personality traits in pilot training success and to explore whether specific emotional characteristics may serve as useful indicators in the selection process.

MATERIAL AND METHODS

Participants

The analysis included data from 22 male military pilot candidates. At the beginning of the study, their mean age was 19 years (SD=1.5, range 18–25). From this larger cohort, individuals who successfully completed their flight training on high-wing aircraft after five years were selected for the current analysis. Within this group, two distinct subgroups were identified based on their training outcomes:

1) F-16 Training Group (n=10): These candidates were selected for further training on F-16 aircraft due to their superior training results. Their mean age at the study's onset was 18.5 years (SD=0.5, range 18–19).
2) Other Aircraft Training Group (n=12): These candidates, who achieved poorer training results, were assigned to training on other types of aircraft. Their mean age at the study's onset was 19.3 years (SD=1.9, range 18–25).

Procedure

The initial Neuroticism scores were obtained from psychological tests administered to military pilot candidates as part of their preliminary selection process. Five years later, after the participants had completed their flight training, a re-assessment of Neuroticism was conducted as part of a periodic psychological evaluation, using a different version of the measurement tool. The overall final instructor evaluation, expressed as a percentage, served as the indicator of flight ability. This score was automatically calculated based on performance in various elements of practical training, including flight preparation, basic and intermediate piloting, and radio communication. The purpose of this follow-up assessment was to verify the consistency of the observed effects of neuroticism over time and to explore which specific facets might be most strongly associated with training progress.

Measures

The following instruments and variables were used in the analysis:

1) Neuroticism (initial assessment): Scores from the Neuroticism scale of the NEO-FFI questionnaire.
2) Neuroticism (follow-up assessment): The overall score and subscale scores (facets) from the Neuroticism scale of the NEO-PI-R questionnaire (Polish adaptation), administered five years after the initial assessment.
3) Flight Ability: The overall final instructor evaluation score from completed flight training, expressed as a percentage. This score was derived from the results across various practical training elements (e.g., flight preparation, basic/intermediate piloting, radio communication).

Statistical Analysis

The analysis presented here had two primary objectives:

1) To determine the extent to which the level of Neuroticism, as assessed in the preliminary study, could predict success in flight training, particularly in the group of trainees for high-wing aircraft. To this end, a correlation analysis was conducted between Neuroticism scale scores and flight training performance.

Tab. 1. Comparison of the main scores in subgroups of pilot candidates.

	F-16 recommended (n=10)		F-16 not recommended (n=12)				
	M	**SD**	**M**	**SD**	**t**	**p**	**Cohen's d**
NEO-FFI	9.50	5.19	5.58	4.96	1.81	ns.	
PI-R	47.80	13.89	37.00	16.59	1.63	ns.	
Instructors' scores	87.82	3.09	72.96	4.38	9.01	<.001	3.98

2) To assess whether the Neuroticism facets profile differentiated the group of individuals recommended for F-16 training from those with poorer training results. For this purpose, a series of intergroup comparisons was performed, comparing the level of each of the six facets of the Neuroticism scale.

With the statistical assumptions met, the analysis was conducted using parametric tests (Pearson's r, Student's t-test), with a significance level set at .05. All statistical analyses presented in the article were carried out using the R software version 4.2.0 (R Core Team, 2022).

Ethical Considerations

The data utilized in this study were obtained from standard, routine selection and psychological assessment procedures for military pilot candidates. These procedures are conducted as part of the official qualification and training process within the Polish Air Force. In accordance with applicable military regulations concerning selection and training, these procedures do not require separate institutional review board (IRB) approval, as they constitute an integral part of the official qualification process. All participants were aware of the purpose of the assessment and its potential implications. Their data were anonymized prior to analysis and used solely for research purposes, maintaining the highest standards of confidentiality and full compliance with current laws and internal regulations of the military institutions.

RESULTS

In the whole group, the mean score on the Neuroticism scale of the NEO-FFI questionnaire was M=7.36 (SD=5.33). This is a result significantly lower (t(21)=-12.51, p<.001, Cohen's d=2.16) than the mean population results in the appropriate age group (M=21.59, SD=7.82) and belongs to the category of low results.

For the NEO-PI-R questionnaire, the mean score on the Neuroticism scale was M=41.91 (SD=16.04). This is also a result significantly lower (t(21)=-13.72, p<.001, Cohen's d=2.65) than the mean population results in the relevant age group (M=88.8, SD=19.3) and also falls into the category of low results.

The results on the Neuroticism scale in the NEO-FFI and NEO-PI-R questionnaires correlate significantly r(20)=0.61, p<.01, which – taking into account the five-year break between measurements and the fact that different versions of the measurement tool were used – indicates a satisfactory stability of the Neuroticism dimension in the study participants.

In the entire group, the average level of overall instructor assessment was M=79.71 (SD=8.46).

The results on the Neuroticism dimension and training grades divided into two subgroups (individuals assigned to training on the F-16 and on another type of aircraft) are presented in Table 1. The distribution of none of the presented results differs significantly from the normal distribution (as verified with the Shapiro-Wilk test).

Relationship of Neuroticism to scores from the aviation training

The confrontation of data from qualification tests with training results shows a moderate, statistically significant predictive value of the results on the Neuroticism scale. The result on the Neuroticism scale of the NEO-FFI questionnaire correlates positively with the overall assessment of the flight training obtained five years later at the level of r(20)=0.477, p<.05. The overall score on the Neuroticism scale of the NEO-PI-R questionnaire, completed after the completed flight training, correlates to a similar degree with the assessment of the training (r(20)=0.482, p<.05).

Between-group differences in Neuroticism facets

In order to determine which of the Neuroticism components significantly differentiated people with higher ratings from those with lower instructor scores, a series of Student's t-tests were conducted comparing the results of the Neuroticism subscales in the groups of people recommended and not recommended for training on the F-16. The results are presented in Table 2.

Tab. 2. Comparison of the Neuroticism facets in subgroups of pilot candidates.

	F-16 recommended (n=10)		F-16 not recommended (n=12)				
	M	**SD**	**M**	**SD**	**t**	**p**	**Cohen's d**
Anxiety	7.20	3.19	5.50	3.29	1.22	ns.	
Hostility	7.50	2.68	4.42	3.92	2.11	.048	0.933
	6.00	3.37	3.92	3.58	1.40	ns.	
Consciousness	9.80	3.77	10.00	3.30	0.13	ns.	
Impulsiveness	11.5	3.24	9.58	3.58	1.30	ns.	
Vulnerability	5.70	2.26	3.59	2.97	1.85	.080	0.807

DISCUSSION

Safety in aviation and the ability to function effectively in a military environment are largely influenced by personality traits that impact decision-making, stress management, and adaptation to specific demands [13]. In the context of risk management, it is crucial to prevent errors arising from impulsivity and heightened emotional tension, as such behavior can lead to poorly considered decisions in situations requiring swift and precise action. The ability to manage stress is also essential—individuals characterized by high emotional stability are better equipped to cope with crisis situations, enhancing their effectiveness in responding to sudden threats [9,15]. Moreover, the analysis of personality traits enables risk profiling, allowing for the identification of individuals with a propensity for risky behavior. This approach is vital for maintaining a high level of safety in aviation. Proper adaptation to the military environment requires not only the ability to manage stress and risk but also alignment with the organizational culture, i.e., the working environment [11]. Discipline, adherence to procedures, and the ability to function within a hierarchical structure form the foundation for effectiveness in the military. Traits such as conscientiousness and emotional control significantly support the adaptation process and are essential within the specific demands of the military aviation environment [5,8,17]. Equally important are motivation and the pursuit of established goals, which influence training progress. A high level of intrinsic motivation helps individuals achieve personal success while also contributing effectively to the team and the organization as a whole. The results of the analysis indicate a positive relationship between the level of neuroticism and the overall rating of flight training. Surprisingly, individuals with low, but not the lowest levels of neuroticism, received better instructor ratings. This finding is noteworthy because, in studies on personality predictors of flight training, it is typically found that lower levels of neuroticism are associated with higher performance. In this study, however, when the results were restricted only to the low range of scores, the opposite trend was observed. This may suggest that individuals with slightly higher levels of neuroticism exhibit greater determination and focus when facing challenges. It is also possible that such individuals are characterized by stronger motivation to overcome difficulties, which is a valuable trait in the demanding profession of a fighter pilot. That said, it is important to note that, compared to the general population, the range of scores on the NEO-FFI and NEO-PI-R questionnaires in the study group indicates relatively low levels of neuroticism. According to the literature, low neuroticism scores are associated with greater psychological resilience, but they may also reflect a tendency toward impression management in the context of selection. It is possible that these candidates aimed to present themselves in the best possible light to their assessors, which also could have influenced the final outcome [4,9].

Although the analysis revealed no statistically significant differences in neuroticism between the groups (those recommended for F-16 training and the others), it is worth considering whether these differences might become more pronounced with a larger sample size. It is also possible that personality traits relevant to selection for F-16 training encompass psychological aspects not included in this analysis but critical for success in training on such an advanced aircraft [17]. The results may suggest that individuals who responded in a more 'balanced' manner (avoiding extreme responses) demonstrate a greater propensity for reflection and insight, which could potentially influence their progress in training. This hypothesis warrants further investigation, particularly in the context of developing more sophisticated psychological assessment tools. It should also be emphasized that the obtained result does not in any way deny that candidates with high levels of neuroticism might struggle to regulate their emotions in stressful situations, potentially leading to impulsive decisions.

However, this same trait might also drive a heightened motivation to respond swiftly in threatening scenarios [4,9].

From the perspective of a pilot's specific responsibilities, it is important to note that the high demands for emotional stability and mental toughness suggest that neuroticism (as understood in the psychological sense) may not necessarily be exclusionary in this profession. In the context of military pilot training, individuals with slightly higher than the lowest levels of neuroticism may demonstrate greater determination, which could manifest as quicker decision-making in high-stress situations.

CONCLUSIONS

In summary, the findings of this study reveal an intriguing relationship between neuroticism and training progress, while also underscoring the need for further research to deepen our understanding of this effect. Although these results are preliminary, they suggest that personality traits, including neuroticism, may hold some predictive value in the context of pilot selection and training progress. However, it is important to acknowledge that these findings may be partially influenced by the selection context and the potential for impression management bias. One of the key findings of this analysis is the recognition of the need for further, more sophisticated research. Due to the small sample size and the limited range of control variables, the results of this study should be regarded as preliminary. To gain a deeper understanding of the relationship between personality traits and success in flight training, future studies should consider additional factors, such as prior flight experience, learning style, analytical ability, and stress response mechanisms.

AUTHORS' DECLARATION

Study Design: Marcin Biernacki, Piotr Zieliński. **Data Collection:** Marcin Biernacki, Piotr Zieliński. **Manuscript Preparation:** Marcin Biernacki, Piotr Zieliński. The Authors declare that there is no conflict of interest.

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