Original Article

Stress and Decision-Making among Civil Aviation Pilots in India: Mediating Role of Cognitive Flexibility

Deepak Lakshmana, Bishal Patangia, Janis Maria Antony, Santosh Kareepadath Rajan
School of Psychological Sciences, CHRIST (Deemed to be University), Bengaluru, Karnataka, India

Abstract

Objective: The study aims to investigate the difference between stress, decision-making, and cognitive flexibility based on demographic factors and the mediating role of cognitive flexibility on the association of stress and decision-making among civil aviation pilots. **Methods:** Data was collected from 372 commercial pilots from India through an online survey. The survey comprises standardized tools, including perceived stress, decision-making, and cognitive flexibility. **Results:** No significant gender difference was found in stress, decision-making, and cognitive flexibility. Age and work experience influenced stress levels, with mid-career pilots reporting the highest stress. Stress has a negative impact on pilots' decision-making ability. Cognitive flexibility partially mediates this relationship. **Conclusion:** Integrating cognitive flexibility training and stress management interventions into pilot training programs could significantly improve decision-making under pressure for safer aviation practices.

Keywords: Civil aviation pilots, cognitive flexibility, decision-making, stress

Introduction

Commercial aviation pilots face a combination of technical, operational, and psychological stressors in the cockpit.[1,2] These stressors, including long duty hours, irregular schedules, and pressure to ensure passenger safety, can significantly elevate stress levels.[3,4] Extensive stress can impair judgment, delay reactions, and lead to a focus on minor details at the expense of critical information.[5] Existing literature links pilots' emotional states to aviation accidents,[6] while environmental stressors hinder information processing.[7,8]

Pilots' decisions, essential for flight safety and operation, range from conducting pre-flight checks to managing in-flight emergencies. However, stress-induced decisions can result in operational inefficiencies or catastrophic events.[4] Cognitive flexibility, the ability to shift perspectives and approach problems from various angles, is a valuable asset for pilots navigating dynamic flight environments.[9] Studies indicate that pilots with strong cognitive flexibility demonstrate enhanced situational judgment,[10] heightened situational awareness, and improved attention management.[11]

Submitted: 01-May-2024 **Revised:** 23-May-2024 **Accepted:** 09-Jul-2024
Published: 31-Mar-2025

Access this article online

Quick Response Code:

Website: https://journals.lww.com/ijoe

DOI: 10.4103/ijoem.ijoem_118_24

The impact of stress is heightened among women pilots due to pre-existing workplace factors and lack of social support.[12] Societal assumptions and subtle biases add pressure on women pilots to prove themselves in a male-dominated field.[13] Additionally, gender differences in cognitive flexibility and stress-coping mechanisms have been observed.[14]

Pilots' age and experience influence their stress perception, decision-making, and cognitive flexibility.[15] Younger pilots, more susceptible to acute stress, exhibit greater cognitive flexibility.[16] Older pilots rely on experience for decision-making but may experience age-related declines in cognitive flexibility.[15]

Stress can hinder cognitive flexibility and compromise decision-making in aviation, where swift responses are crucial.[17] However, higher cognitive flexibility acts as a buffer, allowing pilots to reappraise stressful situations and devise alternative solutions.[18] This highlights the potential mediating

Address for correspondence: Bishal Patangia, School of Psychological Sciences, CHRIST (Deemed to be University), DRC Post, Hosur Road, Bengaluru – 560 029, Karnataka, India.
E-mail: bishal.research@gmail.com

How to cite this article: Lakshmana D, Patangia B, Antony JM, Rajan SK. Stress and decision-making among civil aviation pilots in India: Mediating role of cognitive flexibility. Indian J Occup Environ Med 2025;29:44-8.

role of cognitive flexibility in mitigating stress-induced decision-making errors.

While previous research has examined the relationship between stress, decision-making, and cognitive flexibility in aviation,[19,20] the mediating role of cognitive flexibility remains unexplored.[18] This study addresses this gap by investigating the differences in stress, decision-making, and cognitive flexibility among Indian commercial pilots based on gender, age, and experience. It also examined the association between these factors and the mediating role of cognitive flexibility in stress and decision-making. The findings aim to inform pilot training programs stress management policies and contribute to the broader understanding of occupational stress and decision-making in the Indian aviation industry.[21] Figure 1 illustrates the conceptual framework of this study.

Method

Participants and procedure

A total of 372 commercial pilots in India completed an online survey between November 2020 and March 2021. The sample included 267 males (71.1%) and 105 females (28.3%). Age distribution was 20-30 years (19.2%), 30-40 years (67.1%), and 40-50 years (13.7%). Regarding experience, 18.2% were junior pilots (<5 years), 67.2% were mid-level (5-10 years), and 14.6% were senior (>11 years). Participants were recruited through aviation forums, professional networks, and targeted social media groups. The survey consisted of demographic questions and three psychometric tools: the Perceived Stress Questionnaire (PSQ) to measure stress,[22] the Melbourne Decision-Making Questionnaire (MDMQ) to assess decision-making,[23] and the Cognitive Flexibility Inventory (CFI) to evaluate cognitive flexibility.[24] All three tools demonstrated good reliability in this sample (Cronbach's α: PSQ = 0.964, MDMQ = 0.860, CFI = 0.883). The study was approved by the Centre for Research, Christ University, India with Approval Number CU: RCEC/20/12/20 on 28th December 2020. The participants provided their written informed consent to participate in this study.

Statistical analysis

Following a two-step transformation to achieve normal distribution, independent sample t-tests were used to examine gender differences in stress, decision-making, and cognitive flexibility. One-way analysis of variance was used to assess differences based on age and work experience. Correlation analysis was performed to examine the relationships between the variables. Stepwise regression identified potential predictors of decision-making. Finally, generalized linear mediation (GLM) analysis was conducted to investigate the mediating role of cognitive flexibility in the relationship between stress and decision-making.

Ethical approval

Ethical approval for this study (Research Conduct and Ethics Committee Ref. N° CU: RCEC/20/12/20) was provided by the Research Conduct and Ethics Committee of CHRIST (Deemed to be University), Bengaluru, on 04 December 2020.

Results

The participants reported no significant difference in stress, decision-making, and cognitive flexibility concerning their gender [Table 1].

One-way ANOVA indicated that stress ($F = 7.2$, $P < .01$) and decision-making ($F = 2.1$, $P < .01$) among the pilots differed concerning their age. Stress was higher among the pilots who were 30-40, while decision-making was high among pilots who were 30-40 and 40-50. Stress ($F = 2.2$, $P < 0.5$) among pilots differs based on work experience. Pilots with 6 to 10 years of experience were experiencing higher stress [Table 2].

Correlation analysis shows that stress has a significant negative relationship with decision-making (r = -0.502, $P < 0.001$) and cognitive flexibility (r = -0.196, $P < 0.001$). Cognitive flexibility has a significant positive relationship with decision-making ($r = 0.308$, $P < 0.001$) [Table 3].

Stepwise regression for model 1 shows stress as a significant negative predictor of decision-making ($\beta = -0.502$, $P < 0.01$) with *25%* variance. The model adequately fits (F = 124.70, $P < 0.01$). Similarly, for model 2, stress retained its significant negative effect (β = -0.459, $P < 0.01$), and cognitive flexibility exhibited a significant positive impact ($\beta = 0.218$,

Table 1: Difference between men (n=267) and women (n=105) in stress, decision-making and cognitive flexibility (df=370)

Variables	Men M (SD)	Female M (SD)	t	Cohen's d
Stress	112.1 (9.30)	112.4 (9.30)	-0.320	-0.03
Decision-Making	132.9 (7.52)	131.3 (10.81)	1.601	0.16
Cognitive Flexibility	41.1 (3.56)	40.9 (4.0)	0.232	0.05

Not Significant

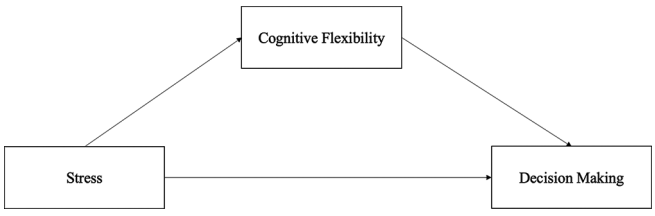

Figure 1: Conceptual framework of the study

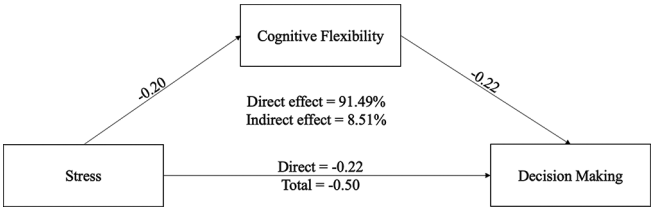

Figure 2: Mediating role of cognitive flexibility in the association of stress and decision-making among civil aviation pilots

Table 2: ANOVA comparing stress, decision-making, and cognitive flexibility on pilots' age group and work experience (*n*=372)

Age	20-30 (*n*=72) M (SD)	30-40 (*n*=249) M (SD)	40-50 (*n*=51) M (SD)	*F*
Stress	107.4 (11.92)	113.5 (8.25)	112.4 (8.05)	7.2**
Cognitive flexibility	132.0 (9.59)	131.9 (10.44)	130.9 (8.44)	0.2
Decision-making	39.8 (5.33)	41.1 (3.48)	41.1 (2.93)	2.1**
Work experience	**1-5 years (*n*=68) M (SD)**	**6-10 years (*n*=250) M (SD)**	**>11 years (*n*=54) M (SD)**	***F***
Stress	109.6 (11.92)	112.9 (8.70)	112.6 (7.68)	2.2*
Cognitive flexibility	132.4 (7.40)	132.1 (10.28)	129.4 (11.36)	1.4
Decision-making	40.3 (5.38)	41.1 (3.46)	40.7 (3.39)	0.9

Notes: Levene's F indicated a lack of homogeneity in stress and decision-making concerning the groups; hence, Welsh's F has been used. *P<0.5, **P<0.01

Table 3: Pearson's correlations of the study variables

Variables	1	2	3
Stress (1)	1		
Decision-Making (2)	-0.502***	1	
Cognitive Flexibility (3)	-0.196***	0.308***	1

***P<0.001

Table 4: Linear regression analysis of stress and decision-making ability

Model	Predictor	β	*t*	r^2	ΔR^2	*F*
1	Stress	-0.502	-11.20**	0.25	-	124.70**
2	Stress	-0.459	-10.33**	0.30	0.05	78.30**
	Cognitive Flexibility	0.218	4.90**			

Dependent Variable: Decision-Making; CF=Cognitive Flexibility.
**P<0.01

$P < 0.01$), with *30%* variance, indicating that the inclusion of Cognitive Flexibility increased the proportion of variance in decision-making explained by the model by *5%*, after controlling for stress. The model is adequately fit ($F = 78.30$, $P < 0.01$) [Table 4].

GLM analysis showed that the indirect effect of stress on decision-making through cognitive flexibility (Stress ⇒ CF ⇒ DM) was statistically significant (B = -0.04, SE = 0.01, β = -0.04, $P < .01$). The indirect effect size was *8.51%* of the total effect of stress on decision-making through cognitive flexibility. The direct effect of stress on decision-making ability (Stress ⇒ DM) was significant (B = -0.42, SE = 0.04, β = -0.46, $P < .01$), explaining *91.49%* of the total effect of stress on decision-making ability. The component effects show that the relationship between stress and cognitive flexibility (Stress ⇒ CF) was significant (B = -0.46, SE = 0.12, β = -0.20, $P < .01$), while the relationship between cognitive flexibility and decision-making ability (CF ⇒ DM) was also significant (B = 0.08, SE = 0.02, β = 0.22, $P < .01$) [Table 5]. Figure 2 is the graphical representation of the mediation model.

Discussion

The current study found no significant gender differences in stress, decision-making, or cognitive flexibility among Indian commercial pilots. This may be attributed to standardized training programs that equip pilots to handle situational stressors, minimizing individual variations in stress response and decision-making.[25] Government initiatives promoting gender diversity in aviation could further contribute to this finding.[26,27] However, it is essential to note that workplace adversity might differentially affect female pilots,[12] and while direct stress responses may be similar, indirect gender-related factors could still influence overall stress and resilience.[28]

Pilots aged 30-40 reported higher stress levels, likely due to career peak pressures, balancing responsibilities, and transitioning into senior roles.[29] Junior pilots, with fewer responsibilities, and senior pilots, with greater control over schedules, experience less stress compared to mid-level pilots.[16] Decision-making ability improved with age, potentially due to experiential learning and greater confidence gained through handling complex scenarios.[15]

Work experience also influenced stress, with pilots having 6-10 years of experience reporting the highest levels. This could be attributed to increased personal responsibilities and the unique emphasis on familial obligations in Indian society.[29] A negative correlation was found between stress and decision-making, aligning with research showing stress impairs cognitive processes crucial for optimal decision-making.[4] Higher cognitive flexibility was associated with better decision-making, likely due to increased situational awareness and adaptability.[5,11]

Stress and cognitive flexibility emerged as significant predictors of decision-making. Stress negatively impacted decision-making, while cognitive flexibility acted as a buffer, enabling informed choices even under pressure.[30] Additionally, cognitive flexibility partially mediated the relationship between stress and decision-making, suggesting that pilots with higher cognitive flexibility could make better decisions even in stressful situations. This aligns with findings from the Korean Air Force, where cognitive flexibility moderated the relationship between work stress and psychological maladjustment.[31] Pilots with higher cognitive flexibility can switch between mental strategies and adjust their responses to changing circumstances, as emphasized by the Dual Process Theory.[32] This ability allows for the engagement of

Table 5: Mediation analysis shows cognitive flexibility as a partial mediator in the relationship between stress and decision-making

Type	Effect	*B*	*SE*	*β*	%	*z*
Indirect	Stress ⇒ CF ⇒ DM	-0.04	0.01	-0.04	8.51	-3.03**
Component	Stress ⇒ CF	-0.46	0.12	-0.20	--	-3.85**
	CF ⇒ DM	0.08	0.02	0.22	--	4.92**
Direct	Stress ⇒ DM	-0.42	0.04	-0.46	91.49	-10.37**
Total	Stress ⇒ DM	-0.46	0.04	-0.50	100	-11.18**

Note: CF=Cognitive flexibility, DM=Decision-Making, *B*=unstandardized beta, *SE*=standard error, *β*=standardized beta, %=percentage of mediation, *z*=*z* score. ***P*<0.01

controlled, analytical decision-making (System 2) even under stress, counteracting potential biases. Furthermore, cognitive flexibility aids in efficiently allocating mental resources, maintaining situational awareness, and mitigating cognitive overload, thus safeguarding decision-making quality amidst stress, as suggested by the Cognitive Control Theory.[33]

Practical implication

The findings provide an overview of the mental health of Indian civil aviation pilots. Implementing mandatory stress management and cognitive flexibility training in pilot education programs could enhance decision-making abilities and stress resilience under pressure.[11] Integrating cognitive flexibility assessments into pilot selection processes may further bolster aviation safety and operational efficiency.[17] Additionally, tailoring interventions to consider age and experience factors could optimize stress management strategies for pilots at different career stages.[15] Notably, this study's absence of gender-based differences highlights the importance of gender-inclusive training and support systems within the aviation industry.[29]

Furthermore, the study emphasizes the need for continuous monitoring of pilots' stress levels and cognitive flexibility to identify those who may benefit from additional support. This research also opens the scope for future studies into the role of personality traits and coping mechanisms in pilots' decision-making tendencies. Collectively, these implications offer guidance for improving decision-making in high-pressure domains while building a safer and more efficient operational environment.

Limitation and future direction

The study's cross-sectional design limits establishing causal relationships and capturing the dynamic evolution of stress, cognitive flexibility, and decision-making over time. Future longitudinal studies could address this limitation. Additionally, the observational nature of the study restricts causal inferences. Experimental designs and longitudinal methodologies could provide more robust evidence for causality. The study's focus on aviation decision-making necessitates caution in generalizing findings to other high-pressure domains. Future research exploring stress and cognitive flexibility dynamics across different professions could enhance the broader applicability of these findings.

Conclusion

The study highlights the vital role of cognitive flexibility in mediating stress and decision-making among Indian commercial pilots. The findings demonstrate the negative impact of stress on pilots' decision-making capabilities. However, cognitive flexibility emerged as a vital protective factor that allowed pilots to maintain judgments even during stressful events. The study reported no gender difference in stress, decision-making, and cognitive flexibility. Mid-career pilots exhibit higher stress levels. Further, this study, as a pioneering study exploring the mediating role of cognitive flexibility among Indian commercial pilots, builds a base for future research into the cultural and regulatory factors that may uniquely shape the stress-decision-making dynamics in the Indian context.

Acknowledgement

The authors would like to thank all the commercial pilots who dedicated their time to participate in this study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Cahill J, Cullen P, Anwer S, Gaynor K, Wilson S. The requirements for new tools for use by pilots and the aviation industry to manage risks pertaining to work-related stress (WRS) and wellbeing, and the ensuing impact on performance and safety. Technologies 2020;8:40.
2. Diarra M, Marchitto M, Bressolle MC, Baccino T, Drai-Zerbib V. A narrative review of the interconnection between pilot acute stress, startle, and surprise effects in the aviation context: Contribution of physiological measurements. Front Neuroergon 2023;41059476.
3. Ekore JO, Allui A, Al Shareef S, Zawawi R. A cross-sectional investigation of prevalence of occupational burnout in Saudi aviation industry. Int J Eng Bus Manag 2020;12:1847979020946919.
4. Kilic B, Ucler C. Stress among ab-initio pilots: A model of contributing factors by AHP. J Air Transp Manag 2019;80:101706.
5. Klaproth OW, Halbrügge M, Krol LR, Vernaleken C, Zander TO, Russwinkel N. A neuroadaptive cognitive model for dealing with uncertainty in tracing pilots' cognitive state. Top Cogn Sci 2020;12:1012-29.
6. Lu T, Li Y, Zhou C, Tang M, You X. The influence of emotion induced by accidents and incidents on pilots' situation awareness. Behav Sci (Basel) 2023;13:231.
7. Venus M, Greder D, Holtforth MG. How professional pilots perceive interactions of working conditions, rosters, stress, sleep problems,

fatigue and mental health. A qualitative content analysis. Eur Rev Appl Psychol 2022;72:100762.
8. Munir A, Aved A, Blasch E. Situational awareness: techniques, challenges, and prospects. AI 2022;3:55-77.
9. Morrow DG, Menard WE, Ridolfo HE, Stine-Morrow EAL, Teller T, Bryant D. Expertise, cognitive ability, and age effects on pilot communication. Int J Aviat Psychol 2003;13:345-71.
10. Ming J, Fang J, Dan L, Can Y, XingXing C. The impact of proactive personality and cognitive flexibility on situational judgment among student pilots in China. In: Proceedings of the 2015 3D International Conference on Advanced Information and Communication Technology for Education. Atlantis Press; 2015. p. 64-7.
11. O'Brien KS, O'Hare D. Situational awareness ability and cognitive skills training in a complex real-world task. Ergonomics 2007;50:1064-91.
12. Douglas S, Pittenger LM. Adversity in aviation: Understanding resilience in the workplace for female pilots. Int J Aerosp Psychol 2020;30:89-103.
13. Davey C, Davidson M. The right of passage? The experiences of female pilots in commercial aviation. Fem Psychol 2000;10:195-225.
14. Wang C, Zhang Z, Wiley JA, Fu T, Yan J. Gender differences in pleasure: The mediating roles of cognitive flexibility and emotional expressivity. BMC Psychiatry 2022;22:320.
15. Kennedy Q, Taylor JL, Reade G, Yesavage JA. Age and expertise effects in aviation decision making and flight control in a flight simulator. Aviat Space Environ Med 2010;81:489-97.
16. Kollmann T, Stöckmann C, Kensbock JM, Peschl A. What satisfies younger versus older employees, and why? An aging perspective on equity theory to explain interactive effects of employee age, monetary rewards, and task contributions on job satisfaction. Hum Resour Manag 2020;59:101-15.
17. Gabrys RL, Tabri N, Anisman H, Matheson K. Cognitive control and flexibility in the context of stress and depressive symptoms: The cognitive control and flexibility questionnaire. Front Psychol 2018;9:2219.
18. Plessow F, Fischer R, Kirschbaum C, Goschke T. Inflexibly focused under stress: acute psychosocial stress increases shielding of action goals at the expense of reduced cognitive flexibility with increasing time lag to the stressor. J Cogn Neurosci 2011;23:3218-27.
19. Zhao Y, Wang Y, Guo W, Cheng L, Tong J, Ji R, *et al*. Studies on the relationship between occupational stress and mental health, performance, and job satisfaction of Chinese civil aviation pilots. Aerospace 2023;10:896.
20. Liang Y, Peng X, Meng Y, Liu Y, Zhu Q, Xu Z, *et al*. Effect of acute stress on working memory in pilots: Investigating the modulatory role of memory load. PLoS One 2024;19:e0288221.
21. Joseph C. Stress coping strategies in Indian military pilots-preliminary observations. Int J Aviat Aeronaut Aerosp 2016;3:1147.
22. Levenstein S, Prantera C, Varvo V, Scribano ML, Berto E, Luzi C, *et al*. Development of the perceived stress questionnaire: A new tool for psychosomatic research. J Psychosom Res 1993;37:19-32.
23. Mann L, Burnett P, Radford M, Ford S. The Melbourne decision making questionnaire: An instrument for measuring patterns for coping with decisional conflict. J Behav Decis Mak 1997;10:1-19.
24. Dennis JP, Vander Wal JS. The cognitive flexibility inventory: Instrument development and estimates of reliability and validity. Cogn Ther Res 2010;34:241-53.
25. Fornette MP, Bardel MH, Lefrançois C, Fradin J, Massioui FE, Amalberti R. Cognitive-adaptation training for improving performance and stress management of air force pilots. Int J Aviat Psychol 2012;22:203-23.
26. Saxena R. How does India have twice as many women airline pilots as the US? 2022. Available from: https://www.aljazeera.com/economy/2022/8/9/how-does-india-have-twice-as-many-women-airline-pilots-than-us. [Last accessed on 2024 Feb 01].
27. Livemint. At 15%, India has most number of female pilots in the world; 2023. Available from: https://www.livemint.com/news/india/at-15-india-has-most-number-of-female-pilots-in-the-world-11679622535369.html. [Last accessed on 2024 Feb 03].
28. Walton RO, Politano PM. Gender-related perceptions and stress, anxiety, and depression on the flight deck. Aviat Psychol Appl Human Factors 2014;4:67-73.
29. Kazmi SSH, Shukla J, Tripathi RK, Zaidi SZH. Occupational stress among middle-aged professionals in India. Annals Neurosci 2024;31:95-104.
30. Junger PM. The Effects of Hypervigilance on Decision-Making During Critical Incidents. University of Texas; 2018.
31. Sung E, Chang JH, Lee S, Park SH. The moderating effect of cognitive flexibility in the relationship between work stress and psychological symptoms in Korean air force pilots. Military Psychol 2019;31:100-6.
32. Evans JStBT, Stanovich KE. Dual-process theories of higher cognition: Advancing the debate. Perspect Psychol Sci 2013;8:223-41.
33. Gluck KA, Ball JT, Krusmark MA. Cognitive control in a computational model of the predator pilot. In: Gray WD, editor. Integrated Models of Cognitive Systems. Oxford University Press; 2007. p. 13-28.