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Team personality characteristics and performance in a simulated large-aircraft instrument control task

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We investigated the relationship between personality characteristics and performance on a simulated large-aircraft instrument control task. The sample comprised 155 undergraduates in China, who completed the Cattell Sixteen Personality Factor Questionnaire to assess personality characteristics, and were randomly allocated to one of 31 teams of five people. We used multiple regression analysis to establish a predictive model of team performance based on team personality elevation and team personality diversity integration models. The results showed that when the team personality elevation integration was used as the independent variable, an increase in rule consciousness led to improvement in team performance, whereas an increase in vigilance, dominance, and social boldness led to a deterioration in team performance. When team personality diversity integration was used as the independent variable, an increase in warmth and openness to change led to improvement in team performance, and an increase in sensitivity led to deterioration in team performance. The simulation task designed in this study provides a specific tool for research involving flight crews on large aircraft. The findings provide a theoretical reference for optimum allocation of flight crews.

Keywords
team personality elevation, team personality diversity, team performance, large aircraft crew, flight simulation

Article Highlights

- Performance of the flight crew of a large aircraft was found to be better when the integration of team personality elevation for the factor of rule consciousness was high and when vigilance, dominance, and social boldness were low.
- Flight crew team performance was better when the integration of team personality diversity for warmth and openness to change were high and sensitivity was low.
- The team instrument control task designed in this study forms a specific tool for research involving the flight crew of large aircraft.

A *team* is a group of two or more individuals who cooperate to achieve a common goal in a specific scenario, with team performance generally being better than individual performance through individual effort (Khasraghi & Hirschheim, 2022). *Team performance* refers to how well the team's expected goal is achieved; it can be measured by the output of teamwork and reflects the effectiveness of a team (Lau & Jin, 2019). A *flight team* refers to the crew of an aircraft who

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execute tasks during flight activities. Increasing the team efficiency of a flight crew and decreasing human error during flight are important goals of crew resource management (Mallinson & Willis, 2020). Large aircraft, such as certain military aircraft that perform special tasks and commercial aircraft that perform long-haul flights, are complex man–machine systems (Nassif, 2019). Because of the complexity of their operation, the control of a large aircraft requires cooperation among multiple individuals. The flight crew includes, among others, pilots and navigators (Mgbemena et al., 2020). Since 64% of flight accidents of aircraft operated by the Civil Aviation Administration of China over the past 10 years were caused by crews (Cullen-Lester et al., 2016), it is necessary to study how the allocation of crews with multiple personnel on large aircraft influences team performance, in order to improve the reliability and stability of aircraft operation (Wai et al., 2021).

Personality traits have long been considered important factors that affect team performance (Prewett et al., 2018), because the unique thoughts, feelings, and behavioral modes reflected by personality characteristics influence not only the contributions of members to the performance of the team's tasks but also the behavioral modes of members (Ormiston et al., 2022). Zhang et al. (2020) stated that the relationship between personality traits and team performance can be attributed partly to differences in team tasks and team structure, and partly to differences in the methods of integrating personality traits at the team level. Examining the influence of team structure on the team's performance under the condition of a specific task mode makes practical sense. Hence, in this study we constructed a team simulation task and tested it to examine the characteristics of crews executing tasks on a large aircraft.

Studies on the influence of the personality characteristics of a team on the team's performance must employ an effective measurement method and integrate individual-level personality characteristics into a team-level personality measurement. Both similarities and differences among team members in terms of personality characteristics will cause differences in team behaviors. Inconsistency in such differences will also influence team effectiveness. Barrick et al. (1998) proposed three different methods to integrate team features: the averaging method, the variance method, and the extremum method.

The *averaging method*, also known as team personality elevation (TPE), reflects the average level of team members on a specific personality characteristic (Chiu et al., 2021). The underlying assumption of TPE is that each team member can affect the team's operational process equally and, thus, can change the team's performance level. Therefore, this method focuses on calculating the overall level of personality traits without considering their distribution among members. Scheutjens (2017) found that the TPE for the personality characteristics of openness to experience, conscientiousness, and extraversion were positively correlated with the innovative performance of the team.

The *variance method*, also known as team personality diversity (TPD), reflects the heterogeneity or degree of variation in personality characteristics among team members. The underlying assumption of TPD is that each team member has an equally important influence on the team's operation, but more emphasis is placed on the differences in the characteristics of the team members. TPD is typically expressed in terms of the variance, standard deviation, or coefficient of variation of team members on a certain personality trait. Researchers have also found positive correlations between TPD and the personality characteristics of emotional stability and extraversion in the context of team performance of sales teams, whereas TPD and the characteristics of openness to experience and conscientiousness have been found to be negatively correlated with team performance (Prewett et al., 2018).

The focus in the *extremum method* is on the team member with the highest or lowest scores for specific personality characteristics. The highest score for specific personality characteristics refers to the maximum value of a certain trait among team members. The lowest score for specific personality characteristics refers to the minimum value of a certain trait among team members.

With respect to the selection of an integration method, scholars have most commonly used TPE and TPD in previous studies. Most authors argue that TPE is an accurate predictor of team performance. However, the prediction results based on TPD are inconsistent. Some authors argue that team performance is positively related to team heterogeneity (Kelsen & Liang, 2019); others argue that the relationship between these variables is negative (Mourelatos et al., 2022).

Other studies have obtained different and even opposite conclusions for the prediction of the same personality characteristic (Soutter et al., 2020). The integration method used may underlie these inconsistencies. LePine et al. (2000) argued that the selection of integration method is closely related to the type of task the team is undertaking. The task classification method of Steiner (1972) provides a basis for the selection of team combination indices: (a) *Additional task:* the task is completed by utilizing all of the team's resources. In this case, the averaging method is suitable. The resources of all team members are needed for team performance and all team members occupy positions of equal importance. (b) *Compensatory task:* different resources provided by different team members can compensate for each other. In this case, the variance method is suitable. The team members' different resources contribute in diverse ways, helping the team to achieve better performance. (c) *Conjunctive task:* requires each team member to achieve the minimum standards of a task. The lowest score for each team member's personal resources plays a crucial role in team performance. Hence, the minimum extremum method is the most appropriate. (d) *Disjunctive task*: the performance depends on the strongest member. As long as one person in the whole team completes the task, the task goal of the whole team will be achieved. Therefore, the maximum score of each team member's personal resources is the best index; accordingly, the maximum extremum method is the most appropriate.

To complete a task on a flight, the resources of all members of the crew of an aircraft are necessary. Moreover, team members' different abilities and interpersonal collaboration are required. The team's performance will be influenced by an individual member's poor performance. Thus, to provide a comprehensive investigation of the effects of personality characteristics on flight crew team effectiveness, in this study we used four measurement indices: the average level TPE, heterogeneity TPD, and maximum and minimum scores for each personality characteristic in the team.

Most previous studies on team personality characteristics have focused on the relationship between team performance and the Big Five model of personality traits. Although all personalities are considered in this model, its restriction to five dimensions may not allow for an understanding of the complexity and fine distinctions of individuals' personality. Thus, in this study we utilized the Cattell Sixteen Personality Factor Questionnaire (Cattell & Mead, 2008) to provide a more comprehensive insight into team personality.

Pilot Study

The crew of a large aircraft includes pilots, a navigator, and other personnel. The tasks of the crew include monitoring information related to the flight instruments, navigation system, and working state of the aircraft. Information is mainly obtained from aircraft instruments. Thus, most of the tasks of the crew involve checking/scanning and reading of various instruments. These tasks require the operators to monitor task information continuously, perform comparative analyses in relation to expected parameters of what they read on the instrument screen/dial, and judge whether the system is operating as expected. When the instrument reading shows that the system deviates from the expected state, corresponding measures must be adopted immediately to ensure the system operates normally according to the requirements of the task. On this basis, we designed a task involving successive monitoring and discrete control tasks. Using OpenGL, we developed an instrument control task for a team of five members to simulate successive monitoring and discrete control tasks during the team operation of a crew on a large aircraft.

Method

Design

The design comprised five similar pointer-type instrument dials on a panel. The middle dial was the master controller and the other dials were for the other team members. Team members have an impact on others when they perform tasks, as determined by the setting of the coefficient K. The task program required participants to monitor information shown on the dials continuously and take action to correct any deviation of the pointer from the designated position. That is, participants performed a continuous monitoring discrete control task. Success was assessed by how well the five team members worked together to control the joystick, overcome mutual influences, and keep the pointers of all dials at the designated position (scale 0). Each team completed a formal test for 60 seconds. The number of times that a

successful readjustment was made so that the pointer resumed the designated position during the test period of 60 seconds was taken as the measure of team performance. The task framework is shown in Figure 1, where the collective influences of the team members on the task can be seen. The influence coefficient was K = K2/K1, where K1 is the coefficient of the independent joystick controls and K2 is the coefficient of the interaction of team members for the joystick controls. The test instrument panel for the team control task is shown in Figure 2. The panel for the experimenter is shown in Figure 3.

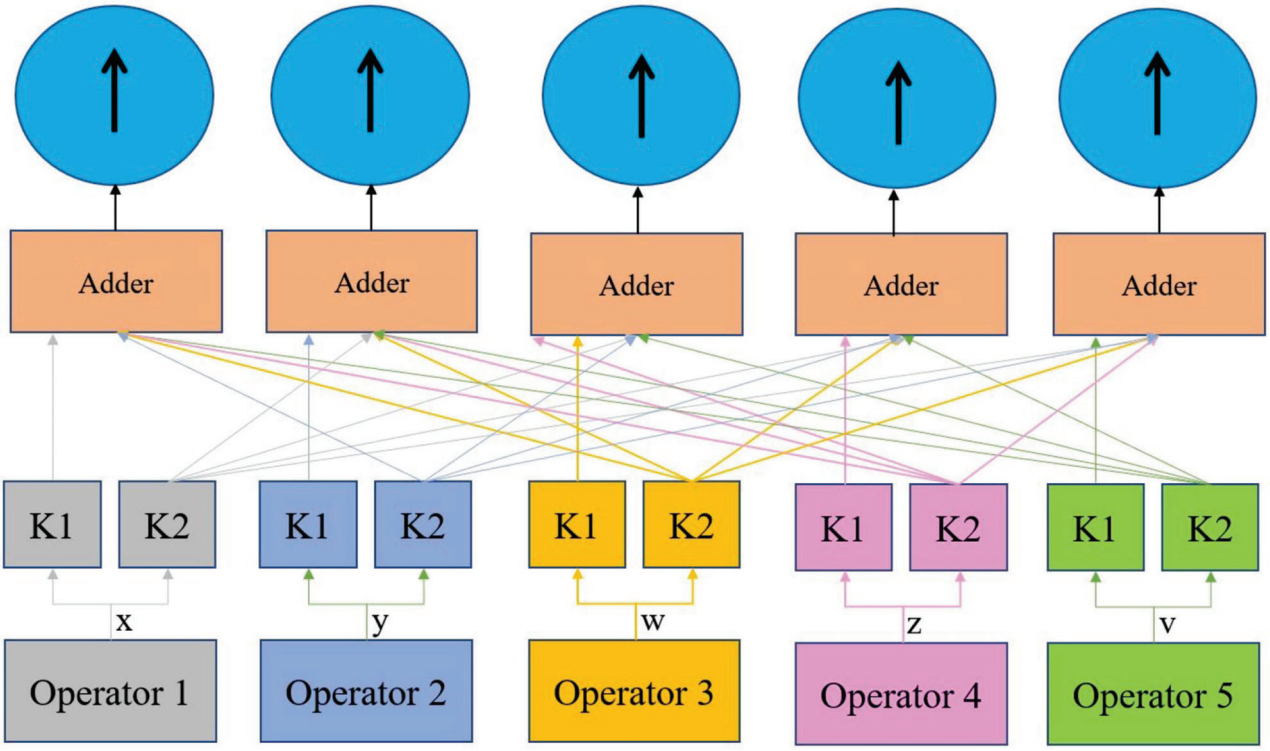

Figure 1. *Team Instrument Control Task*
Note. The blue circles with the arrows represent the five dials on the control panel.

Figure 2. *Team Members' Instrument Control Panel*

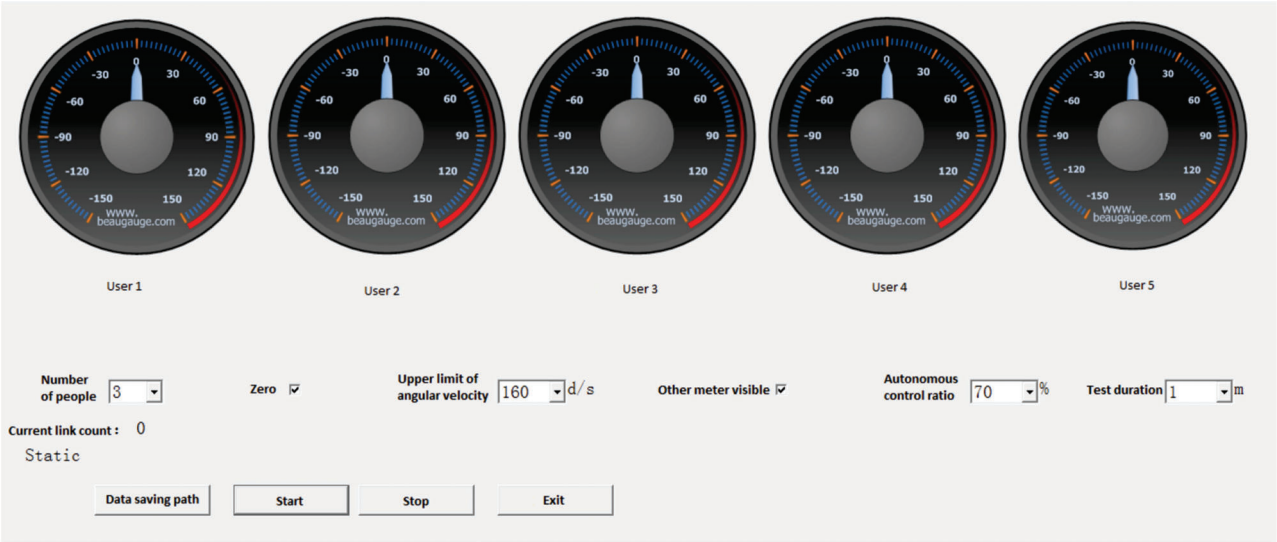

Figure 3. *Experimenter's Instrument Control Panel*

Participants and Procedure

The crew on a large aircraft is often sent on long-haul flights or specific military missions. Given that most crewmembers working on large aircraft in China are men, especially in the military field, all of our participants were men. We used random sampling to select students at Air Force Medical University, China, and allocated each student to one of 31 teams, with five members in each. Participants had a mean age of 18.98 years (*SD* = 0.56) and all were right-handed. None had participated in a similar experiment before. All experimenters received standard training on the instruction and process. For each group, preparation before the experiment took 20 minutes. First, the experimenters presented the standard instructions and described the task content, which took 10 minutes. The participants then had 5 minutes to practice the task and familiarize themselves with the rules. Next, each team had 5 minutes to discuss the task before completing the official test. In the process of task completion, team members were allowed to communicate to determine the strategy. The same participants completed the task a second time 2 months after the first test to examine the test–retest reliability. Between the two task completions, they received no training related to the task content. Performance data for the team were collected automatically by the computer program used for the task. Descriptive statistics were calculated, and *t* tests and correlation analyses were performed using SPSS 21.0 software.

Results

The results in Table 1 show that team performance was normally distributed, meeting the requirements for parametric analysis. According to the 27% rule (Drach-Zahavy & Somech, 2002), participants were selected for high- and low-performance groups, respectively, based on their performance on the team instrument control task. The pass rate was calculated according to mean score/highest score. The mean pass rate of the high- and low-score groups was used as the coefficient of difficulty, $P = (P_H + P_L)/2$. The difference in the pass rate between the high- and low-score groups was used as the measure of discrimination for the task ($D = P_H - P_L$). The P (difficulty) and D (discrimination) values are shown in Table 2. The results indicated that the task was moderately difficult and had good discrimination. It reached the project identification index (.40) proposed by Furr (2021).

Table 1. *Descriptive Statistics and Normality Test of Team Performance*

M	*SD*	Kurtosis	Skewness	KS-Z	*p*
7.81	2.13	0.67	0.72	.75	.61

Note. KS-Z = value (Z) of a single sample in the Kolmogorov–Smirnov test.

Table 2. *Analysis of Difficulty and Discrimination of Task*

Pass rate			
High-scoring group	Low-scoring group	Difficulty	Discrimination
.85	.44	.64	.41

When we conducted the test again 2 months later, there was no significant difference in the performance of the two groups between the first and second tests and the correlation was relatively high (see Table 3). This task was based on psychomotor ability, which is a unique ability. There is a very low correlation between psychomotor performance on operational tests and pen-and-paper tests, and the correlation between psychomotor performance on a motor test and the speed and quality of movement is low. The reliability of psychomotor skills is lower than that of other skills (e.g., basic cognitive skills), which may be affected by practice or exercise, ranging between .70 and .87 (Labbé et al., 2020). Accordingly, we used this task for the subsequent experiment.

Table 3. *Test–Retest Reliability of Simulated Task*

First performance	Second performance	*t*	*p*	*r*
7.81 ± 2.13	7.89 ± 2.26	0.18	.85	.82**

Note. ** $p < .01$.

Main Study

Method

Participants

Participants were 155 undergraduates at Air Force Medical University in China, who were majoring in aerospace medicine and who volunteered to take part in the experiment. All the students were men aged 17–19 years, with normal or corrected vision, and had not previously participated in similar experiments. At the end of the experiment the participants were provided with feedback based on their results for the 16PF Questionnaire, and compensation of RMB 200 (USD 27.67) was issued to each participant. Our study received ethical approval from the Medical Ethics Committee of the First Affiliated Hospital of the Air Force Medical University (KY20213086-1), and all participants gave informed consent.

Procedure

First, the participants completed the 16PF Questionnaire on a computer. They were randomly allocated to one of two groups that were tested on consecutive days between 9:00 am and 11:00 am.

Then, the participants were each randomly allocated to one of 31 teams, with five members in each, and they completed the instrument control task we had designed for five-member teams. All experimenters received standard training on the instruction and process. The experimenters presented the standard instructions, described the task, and gave the participants 5 minutes to practice and familiarize themselves with the rules. Then, the participants were given 5 minutes to discuss the task as a team before the official test ran for 5 minutes. During the official test, team members were allowed to communicate with each other and determine task strategies. Team performance was measured automatically by the computer. To control for the influence of biological rhythm on performance, out of the 31 teams, four were randomly selected on each of the days of testing; two of these teams were tested between 9:00 am and 11:00 am, and two were tested between 2:00 pm and 5:00 pm.

Measures

Personality Test. We used the Cattell Sixteen Personality Factor Questionnaire (16PF; Cattel & Mead, 2008) to measure personality traits.

Basic Cognitive Ability Tests. We used a test of basic cognitive ability in spatial rotation and instrument comprehension that was developed by a civil aviation company in China for use in recruitment. It has shown good validity.

Team Task

The task used in this study was the team instrument control task used in the pilot study. The number of successful adjustments to the instrument panel within the test time was taken as the measure of team performance.

Data Analysis

SPSS 21.0 was used for data entry and statistical analysis. Factor analysis, descriptive statistical analysis, and correlation analysis were performed; an alpha level of $p < .05$ was taken to be statistically significant.

Results

Scores for team performance were generated by the computer at the conclusion of each task. These were used for descriptive statistical analysis, as shown in Table 4.

Table 4. *Descriptive Statistics on Team Performance*

	M	*SD*	Maximum value	Minimum value
Team performance	7.89	2.26	12.71	2.10

Note. $N = 31$.

The individual-level personality characteristics, as measured by the 16PF, were integrated and presented as TPE, TPD, and team personality extremum. The descriptive statistics for these four team-level integration indices are presented in Table 5.

Table 5. *Descriptive Statistics for Team-Level Personality Characteristic Indices*

Factor	Team personality elevation	Team personality diversity	Max.	Min.
Warmth	5.67 ± 0.78	1.61 ± 0.54	7.75 ± 1.15	3.67 ± 0.92
Reasoning	6.36 ± 0.67	1.40 ± 0.59	7.96 ± 0.76	4.46 ± 1.37
Emotional stability	7.03 ± 0.86	1.87 ± 0.59	9.16 ± 0.92	4.71 ± 1.34
Dominance	6.57 ± 0.74	1.74 ± 0.67	8.58 ± 0.94	4.28 ± 1.24
Liveliness	7.19 ± 1.00	1.78 ± 0.58	9.16 ± 0.98	4.75 ± 1.35
Rule consciousness	5.97 ± 0.65	1.74 ± 0.69	8.05 ± 0.95	3.72 ± 1.37
Social boldness	6.62 ± 0.92	1.82 ± 0.54	8.75 ± 0.86	4.32 ± 1.37
Sensitivity	5.32 ± 0.89	1.82 ± 0.75	7.61 ± 1.41	3.14 ± 1.08
Vigilance	3.35 ± 0.79	1.58 ± 0.59	5.29 ± 1.28	1.55 ± 0.80
Abstractedness	6.20 ± 0.67	1.40 ± 0.60	7.90 ± 1.12	4.48 ± 1.22
Privateness	5.46 ± 0.76	1.42 ± 0.50	7.22 ± 1.05	3.72 ± 1.03
Apprehension	3.56 ± 0.59	1.48 ± 0.58	5.57 ± 1.30	1.93 ± 0.73
Openness to change	5.76 ± 0.71	1.18 ± 0.49	7.04 ± 1.01	4.22 ± 1.13
Self-reliance	5.12 ± 0.51	1.59 ± 0.56	7.13 ± 0.89	3.22 ± 0.98
Perfectionism	6.22 ± 0.71	1.54 ± 0.54	8.06 ± 0.83	4.20 ± 1.10
Tension	4.81 ± 0.81	1.68 ± 0.49	6.98 ± 1.06	2.83 ± 0.74

Note. $N = 31$.

The four team personality integration indices were included in a partial correlation analysis in SPSS. We controlled for basic cognitive ability. The relationship between team personality characteristics and team performance was tested, and the results are presented in Table 6.

Table 6. *Correlations Between Team Personality Characteristics and Team Performance*

Factor	Team performance			
	Team personality elevation	Team personality diversity	Max.	Min.
Warmth	–.101	.421**	.212	–.210
Reasoning	.115	–.062	.241	.103
Emotional stability	.199	.262	.030	.237
Dominance	–.343*	.199	–.305	.079
Liveliness	–.124	.285	.125	–.137
Rule consciousness	.451**	.271	.049	–.108
Social boldness	–.290*	.221	–.051	.266
Sensitivity	–.192	–.315*	–.388*	–.157
Vigilance	–.361*	.122	.235	–.022
Abstractedness	.081	–.011	–.055	.140
Privateness	–.134	–.062	.233	.389*
Apprehension	.335	.271	–.434	–.172
Openness to change	–.315*	.299*	–.128	.146
Self-reliance	.029	.187	.123	.058
Perfectionism	.001	.028	–.051	–.050
Tension	.288	.055	.027	–.157

Note. $N = 31$.
* $p < .05$. ** $p < .01$.

The results showed that when TPE was used as the independent variable to integrate the team personality characteristics, rule consciousness was positively related to team performance. The higher the team level of rule consciousness, the better the team performance. The characteristics of dominance, social boldness, vigilance, and openness to change were all negatively correlated with team performance. Yang et al. (2022) found that if the team levels of dominance and social boldness are high, team members will be reluctant to obey others' instructions, which will make it difficult for the team to cooperate effectively, thus impacting performance.

When TPD was used as the independent variable to integrate the team personality characteristics, warmth and openness to change were positively correlated with team performance, and sensitivity was negatively correlated with team performance. When the team members have great differences in degree of warmth, they can balance the team roles, which will improve team performance. Warmth in the 16PF is correlated with extraversion in the Big Five personality traits (Gerbing & Tuley, 1991). Researchers have also found that heterogeneity of extraversion in team members is conducive to the improvement of team performance (Drach-Zahavy & Somech, 2002). Members with high extraversion may be more inclined to cooperate and more suitable for the role of leader, whereas introverted team members are more agreeable and compliant. This combination may increase the cohesion of the team and reduce conflict, facilitating the cooperation needed for task success (Hui et al., 2023). Team heterogeneity of openness to change was found to be positively correlated with team performance. Team members with a high level of openness to change are inclined to explore novel methods and approaches, whereas those with a low level of openness to change tend to adopt more conservative approaches. The presence of both personality types in a team can foster a harmonious, cooperative atmosphere and lead to the proposal of superior task solutions (Grailey et al., 2023). When the integrated team personality extremum was used as the independent variable, privateness minimum was positively related to team performance, and sensitivity maximum was negatively related to team performance. Descriptors of privateness in the low-score range are forthright, genuine, and spontaneous. Descriptors of privateness in the high-score range are polished and socially aware (Cattell & Mead, 2008). Members of the teams with low privateness exhibit spontaneousness and highly emotional responses, which may be adverse to teamwork (Goran et al., 2012), impacting the level of cooperation.

According to the above partial correlation analysis, among the four integration modes of team personality, the results show that more of the 16PF dimensions affected team performance either negatively or positively when team members' scores were integrated using TPE and TPD than was the case for maximum and minimum values for the 16 dimensions.

Therefore, we conducted a backward multiple regression analysis using TPE and TPD integration of team personality traits as independent variables and team performance as the dependent variable, and compared the coefficient of determination (R^2). On the basis of the significance level of the regression equation F distribution test, we selected the best regression model. The regression model results for team performance are shown in Table 7.

Table 7. *Regression Models of Team Personality Characteristics and Team Performance*

	Team personality elevation			Team personality diversity		
	R^2	F	p	R^2	F	p
1. Model 1	.212	1.537	.200	.165	1.395	.256
2. Model 2	.363	2.518	.033	.257	1.793	.122
3. Model 3	.389	5.694	.001	.347	6.669	.001

Note. The variables included in Model 1 for team personality elevation (TPE) are dominance, social boldness, vigilance, openness to change, warmth, and rule consciousness. The variables in Model 2 TPE are dominance, social boldness, vigilance, openness to change, and rule consciousness. The variables in Model 3 TPE are dominance, social boldness, vigilance, and rule consciousness. The variables included in Model 1 team personality diversity (TPD) are warmth, sensitivity, liveliness, emotional stability, and openness to change. The variables included in Model 2 TPD are warmth, sensitivity, liveliness, and openness to change. The variables included in Model 3 TPD are warmth, sensitivity, and openness to change.

As can be seen from Table 7, when the TPE personality model of integration was used, the independent variable explained 38.9% of the variance in team performance, and the regression model was optimal. The regression coefficients are shown in Table 8.

Table 8. *Regression Coefficients of Team Personality Elevation*

Factor	β	t	p
Dominance	–1.245	–2.883	.008
Social boldness	–1.701	–3.345	.002
Vigilance	–1.229	–3.525	.002
Rule consciousness	1.017	2.304	.029

Note. The constant term was 28.56.

As can be seen from Table 7, when the TPD team personality model of integration was used, the independent variable explained 34.7% of the variation in team performance, and the regression model was optimal. The regression coefficients are shown in Table 9.

Table 9. *Regression Coefficients of Team Personality Diversity*

Factor	β	t	p
Warmth	.383	2.364	.025
Sensitivity	–.245	–2.571	.016
Openness to change	.367	2.775	.010

Note. The constant term was 7.425.

Discussion

In this experiment we developed an instrument control panel task for teams to simulate continuous monitoring on flights by a five-member crew of a large aircraft. It was an interdependent task; the behaviors of each team member had mutual influences, so that close cooperation was needed to achieve the goals through continuous monitoring of information and discrete operations to control changes. These features are consistent with the requirements of long-haul flights and missions on large military aircraft.

The results reveal that personality factors that were positively correlated with team performance included rule consciousness, warmth, openness to change, and privateness. A team with high TPE for rule consciousness usually exhibits a high constant level of responsibility and insists on completing the formulated task goal (Kraska, 2020). Compared with other teams, a team with this characteristic is better able to form a long-term cooperative relationship by focusing on meeting the needs of the task, thus facilitating successful completion. In the actual implementation of long-haul flights and military missions, high TPE of rule consciousness is beneficial to task execution.

When heterogeneity of team warmth is relatively high, the team can still achieve relatively good performance. High warmth heterogeneity reflects great differences in the degree of extraversion among team members. This avoids team cohesion problems that may arise when many members are extraverted, while also avoiding the potential for a lack of communication when members are all introverted. A combination of extraverted and introverted team members can provide a balance in team roles to facilitate improvement in team performance. Similarly, we found that heterogeneity in openness to change within the team was positively correlated with team performance. Being very open to change and experiment reflects that team members are relatively radical. They like to explore new ways and means. On the contrary, team members who are not very open to change prefer to use familiar methods and approaches to work. The coexistence of members with both high and low openness to change in a team offers a relatively more harmonious cooperative atmosphere and leads to proposals of superior task solutions (Grailey et al., 2023). A team with minimum privateness is assessed according to the member with the lowest privateness level. Those with low privateness are forthright, genuine, and spontaneous (Cattell & Mead, 2008), which may be adverse to teamwork (Goran et al., 2012). If the privateness level of this member is too low, they may become an erratic influence on the team and may impact the cooperation level of the team.

Factors that were negatively correlated with team performance in our study included dominance, social boldness, vigilance, and sensitivity. When team vigilance is relatively high, that is, the members are suspicious and skeptical (Cattell & Mead, 2008), there is reduced trust among team members. In the task developed for this study the behavioral dependence among members was very high and a sense of distrust decreased effective cooperation among members, thus influencing team performance. The same thing is true in the context of crew on long-haul flights or military missions. When team dominance is relatively high, most team members are assertive (Cattell & Mead, 2008). They all hope to stick to their own assertion. It is difficult to form effective cooperative relationships in such a team, and conflict can easily occur, which will influence the successful completion of team tasks. Similarly, when the team social-boldness level is relatively high, team members will tend to be careless and ignore details, although they are adventurous. Team members in our study had to observe carefully and pay attention to dynamic information. Thus, high social boldness would surely influence the cooperation process. Descriptors of sensitivity in the low-score range are tough-minded and utilitarian. Descriptors of sensitivity in the high-score range are tender-minded and sensitive (Cattell & Mead, 2008). These two different personality types will lead to different modes of interaction between team members, which might cause unnecessary disputes, thus hindering the team cooperation process.

In this study we used backward regression to obtain two optimal regression equations with TPD and TPE as independent variables and team performance as the dependent variable, in order to explore the predictive effect of personality factors on team performance. According to the correlations between the Big Five personality traits and personality characteristics included in the 16PF, we found that the regression results for vigilance TPE and for both rule consciousness and dominance TPE on team performance were consistent with those reported in a previous study (Schmutz et al., 2019).

At the same time, we found that the regression result for TPE social boldness on team performance was consistent with the study Williamson and Lounsbury (2016) conducted with librarians, where the work required cautiousness and deliberateness. The team task in our experiment required a high level of rigor from the members, including careful observation of information changes and timely correction of coordination methods. In this case, high social boldness in the team is not conducive to careful and cautious cooperation, thus adversely impacting performance.

The vigilance factor was a significant predictor of performance. This highlights the importance of trust in the flight team. Flight personnel are exposed for long periods of time to a working environment that includes oxygen deficiency, noise, vibration, and pressure change. This can lead to sustained physical and mental stress. The crew also needs to process and interpret information rapidly under conditions of high mental pressure. In this situation it is necessary to recognize others' interpretations and behavior patterns to avoid unnecessary disputes and conflicts, so that interpersonal trust among crew members is particularly important for ensuring flight safety.

With the development of technology and improvements in the reliability of equipment, the main causes of flight accidents have changed from mechanical and weather factors to human factors. As aircraft crews are the direct manipulators of the aircraft, the judicious match of personality characteristics of crew members is crucial to improving flight safety. As such, attention should be paid to team building to avoid serious consequences from the mistakes or negative acts of one weak crew member. When assigning crew members to a flight, according to the results of our study three aspects should be considered: First, TPE is related to team performance. Therefore, the baseline of skill levels should not be the only consideration for selection of crew. Specifically, the TPE of the personality characteristics of the team, in terms of rule consciousness and vigilance, should be considered. To reach a certain baseline to promote the optimal operation of the flight crew in completing flight tasks effectively, members must be able to form mutual trust and communicate and cooperate well.

Second, the results of this study indicate that heterogeneity of the team in the personality factors of warmth and openness to change enhanced team performance. The heterogeneity of team members in certain personality traits may be positively correlated with team performance. A lack of a central authority to distinguish between the primary and secondary controller may result in program confusion and blind spots the team cannot address. Differences in the personality characteristics of the crew members can help achieve this. As such, members with complementary personality characteristics should be chosen, especially in relation to the personality dimensions of warmth and openness to change.

Third, according to the results of this study TPE was closely related to team performance, with an extremum effect in team personality. Specifically, the minimum value of privateness was positively associated with team performance. This indicates that when a crew includes an individual who cannot communicate well with other members, team cooperation may be impacted, which will negatively influence the performance of the aircraft crew.

Limitations and Future Research Directions

Our findings provide insight into the relationships between the independent variables of TPE and TPD, as well as the dependent variable of team performance, without involving team processes. In subsequent research the relationships between team performance and team processes could be examined. Further, in this study we included only men as participants, and although they were undergraduate students majoring in aviation medicine, there are some differences between students and people who are actually employed as pilots. In future research our findings could be verified with a sample of pilots. In addition, the proposed regression model for team performance was not validated in this study. Future research could examine the predictive effectiveness of the model with a sample of pilots.

Conclusion

This study provides theoretical guidance for selecting crew members for aircraft that perform long-haul flights or certain military missions. The multiple regression equations constructed in this study can be used for personnel selection. The team task designed for this experiment provides a useful tool for further studies of crews in the operation

of large aircraft. However, in the actual application process, it is still necessary to combine the specific conditions such as aircraft model, task type, and team size, and to allocate different weights of team personality, to select appropriate collocation methods and produce more efficient flight teams.

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References

Barrick, M. R., Stewart, G. L., Neubert, M. J., & Mount, M. K. (1998). Relating member ability and personality to work-team processes and team effectiveness. *Journal of Applied Psychology*, *83*(3), 377–391. https://doi.org/10.1037/0021-9010.83.3.377

Cattell, H. E. P., & Mead, A. D. (2008). The Sixteen Personality Factor Questionnaire (16PF). In G. J. Boyle, G. Matthews, & D. H. Saklofske (Eds.), *The Sage handbook of personality theory and assessment* (Vol. 2, pp. 135–159). Sage. https://tinyurl.com/3n6k92p8

Chiu, C.-Y. C., Lin, H.-C., & Ostroff, C. (2021). Fostering team learning orientation magnitude and strength: Roles of transformational leadership, team personality heterogeneity, and behavioural integration. *Journal of Occupational and Organizational Psychology*, *94*(1), 187–216. https://doi.org/10.1111/joop.12333

Cullen-Lester, K. L., Leroy, H., Gerbasi, A., & Nishii, L. (2016). Energy's role in the extraversion (dis)advantage: How energy ties and task conflict help clarify the relationship between extraversion and proactive performance. *Journal of Organizational Behavior*, *37*(7), 1003–1022. https://doi.org/10.1002/job.2087

Devlin, S. P., Flynn, J. R., & Riggs, S. L. (2018). Connecting the Big Five taxonomies: Understanding how individual traits contribute to team adaptability under workload transitions. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, *62*(1), 119–123. https://doi.org/10.1177/1541931218621027

Drach-Zahavy, A., & Somech, A. (2002). Team heterogeneity and its relationship with team support and team effectiveness. *Journal of Educational Administration*, *40*(1), 44–66. https://doi.org/10.1108/09578230210415643

Furr, R. M. (2021). *Psychometrics: An introduction* (4th ed.). Sage.

Gerbing, D. W., & Tuley, M. R. (1991). The 16PF related to the five-factor model of personality: Multiple-indicator measurement versus the a priori scales, *Multivariate Behavioral Research*, *26*(2), 271–289. https://doi.org/10.1207/s15327906mbr2602_5

Goran, K., Lazarević, L., Jakovljević, S., Bačanac, L., & Eminović, F. (2012). Personality characteristics of Serbian male wheelchair and professional basketball players. *Acta Gymnica*, *42*(2), 41–47. https://doi.org/10.5507/ag.2012.011

Grailey, K., Lound, A., Murray, E., & Brett, S. J. (2023). The influence of personality on psychological safety, the presence of stress and chosen professional roles in the healthcare environment. *PLoS ONE, 18*(6), Article e0286796. https://doi.org/10.1371/journal.pone.0286796

Hui, D., Zhang, L., Huang, M., Dang, W., Cheng, S., Xiong, K., … Ma, J. (2023). Heterogeneity of personality and cognitive ability: Effects on flight team performance. *Social Behavior and Personality: An international journal*, *51*(7), Article e12256.
https://doi.org/10.2224/sbp.12256

Kelsen, B. A., & Liang, H.-Y. (2019). Role of the Big Five personality traits and motivation in predicting performance in collaborative presentations. *Psychological Reports*, *122*(5), 1907–1924.
https://doi.org/10.1177/0033294118795139

Khasraghi, H. J., & Hirschheim, R. (2022). Collaboration in crowdsourcing contests: How different levels of collaboration affect team performance. *Behaviour & Information Technology*, *41*(7), 1566–1582.
https://doi.org/10.1080/0144929X.2021.1887354

Kraska, J. (2020). *Personality predictors of athletic performance in collegiate athletes* (Doctoral dissertation). California Lutheran University.
https://tinyurl.com/5ypn66kb

Labbé, M., Young, M., Mascarella, M., Husein, M., Doyle, P. C., & Nguyen, L. (2020). How consistent is competent? Examining variance in psychomotor skills assessment. *Academic Medicine*, *95*(5), 771–776.
https://doi.org/10.1097/ACM.0000000000002985

Lau, K. H., & Jin, Q. (2019). Chinese students' group work performance: Does team personality composition matter? *Education + Training*, *61*(3), 290–309.
https://doi.org/10.1108/ET-06-2018-0141

LePine, J. A., Hanson, M. A., Borman, W. C., & Motowidlo, S. J. (2000). Contextual performance and teamwork: Implications for staffing. *Research in Personnel and Human Resources Management*, *19*, 53–90.
https://doi.org/10.1016/S0742-7301(00)19003-6

Mallinson, T., & Willis, S. (2020). The zero point survey and egg-timer model combined for crew management. *Journal of Paramedic Practice*, *12*(11), 430–435.
https://doi.org/10.12968/jpar.2020.12.11.430

Mgbemena, C. E., Ejichukwu, E. O., Okpala, C. C., & Mgbemena, C. O. (2020). Man-machine systems: A review of current trends and applications. *Fupre Journal of Scientific and Industrial Research*, *4*(2), 91–117.
https://tinyurl.com/yrsy4hnx

Mourelatos, E., Giannakopoulos, N., & Tzagarakis, M. (2022). Personality traits and performance in online labour markets. *Behaviour & Information Technology*, *41*(3), 468–484.
https://doi.org/10.1080/0144929X.2020.1815840

Nassif, A. G. (2019). Heterogeneity and centrality of "dark personality" within teams, shared leadership, and team performance: A conceptual moderated-mediation model. *Human Resource Management Review*, *29*(4), Article 100675.
https://doi.org/10.1016/j.hrmr.2018.11.003

Ormiston, M. E., Wong, E. M., & Ha, J. (2022). The role of CEO emotional stability and team heterogeneity in shaping the top management team affective tone and firm performance relationship. *The Leadership Quarterly*, *33*(3), Article 101543.
https://doi.org/10.1016/j.leaqua.2021.101543

Prewett, M. S., Brown, M. I., Goswami, A., & Christiansen, N. D. (2018). Effects of team personality composition on member performance: A multilevel perspective. *Group & Organization Management*, *43*(2), 316–348.
https://doi.org/10.1177/1059601116668633

Scheutjens, A. A. M. (2017). *The effects of personality elevation and functional heterogeneity on innovation in work-teams: A meta-analysis* (Master's thesis). Tilburg University.
https://tinyurl.com/bddsuzdw

Schmutz, J. B., Meier, L. L., & Manser, T. (2019). How effective is teamwork really? The relationship between teamwork and performance in healthcare teams: A systematic review and meta-analysis. *BMJ Open*, *9*(9), Article e28280.
https://doi.org/10.1136/bmjopen-2018-028280

Soutter, A. R. B., Bates, T. C., & Mõttus, R. (2020). Big Five and HEXACO personality traits, proenvironmental attitudes, and behaviors: A meta-analysis. *Perspectives on Psychological Science*, *15*(4), 913–941.
https://doi.org/10.1177/1745691620903019

Steiner, I. D. (1972). *Group process and productivity*. Academic Press.

Wai, A. K. C., Lam, V. S. F., Ng, Z. L. H., Pang, M. T. H., Tsang, V. W. Y., Lee, J. J. J., & Wong, J. Y. H. (2021). Exploring the role of simulation to foster interprofessional teamwork among medical and nursing students: A mixed-method pilot investigation in Hong Kong. *Journal of Interprofessional Care*, *35*(6), 890–898.
https://doi.org/10.1080/13561820.2020.1831451

Williamson, J. M., & Lounsbury, J. W. (2016). Distinctive 16 PF personality traits of librarians. *Journal of Library Administration*, *56*(2), 124–143.
https://doi.org/10.1080/01930826.2015.1105045

Yang, S., He, X., Wang, S., Song, J., & Cheng, H. (2022). A preliminary study on the personality characteristics of clinical medicine teachers [In Chinese]. *China Continuing Medical Education*, *14*(10), 125–132.
https://doi.org/10.3969/j.issn.1674-9308.2022.10.033

Zhang, X., Chen, G., & Xu, B. (2020). The influence of group Big-Five personality composition on student engagement in online discussion. *International Journal of Information and Education Technology*, *10*(10), 744–750.
https://doi.org/10.18178/ijiet.2020.10.10.1452