Emotional Intelligence and Emotional State Effects on Simulated Flight Performance

Jing Dai; Hang Wang; Lin Yang; Zhihong Wen

BACKGROUND: Flight cadets' emotion is a factor of great importance to flight training. So it is of profound significance to address how emotional factors affect flight training performance. The present study aimed to investigate the relationship between emotional intelligence (EI) and simulated flight performance (SFP), and explore the mechanism of emotional state as a mediator in the effect of EI on SFP.

METHODS: Ninety undergraduates took part in the study. EI (Wong and Law Emotional Intelligence Scale), neuroticism (Eysenck Personality Questionnaire Revised), anxiety (State Anxiety Inventory), and tension (Profile of Mood States) were collected. Conducted were 9 h of simulated flight training in a simulator of the Type 6 Primary Trainer. The Delphi Experts Grading Method was used to assess students' SFP. Mediation effect of emotional state was explored using regression analysis.

RESULTS: EI was significantly correlated with neuroticism ($r = -0.31$), tension ($r = -0.31$), and anxiety ($r = -0.31$), respectively. Multiple mediation effects showed that emotional state mediated the association between EI and SFP. Tension especially mediated the associations between the Self Emotion Appraisals and Regulation of Emotion dimensions of EI and SFP. However, the Use of Emotion dimension of EI had a direct negative effect on SFP without the mediating role of emotional state.

DISCUSSION: The findings indicated that EI was significantly correlated with emotional state (neuroticism, tension, and anxiety). EI may directly or indirectly affect SFP and tension played an important mediating role. Implications for the promotion of EI and emotional state to enhance performance in real flight training are discussed.

KEYWORDS: emotional intelligence, neuroticism, tension, anxiety, simulated flight training, mediating effect.

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Pilots' psychological state has an important influence on flight safety.[31] It is important for pilots to perceive and regulate their emotional state under extreme or stressful situations, which is especially crucial for flight safety. Similarly, flight cadets, who are just starting to learn to fly, may feel anxious, nervous, or scared during their first flight, so good emotional regulation ability is essential. Civil piloting requires pilots to have excellent psychological qualities and the assessment of psychopathology has been used in the select-out process in the selection of pilots.[15] At present, the contents of psychological selection for civil aviation pilots in China mainly focus on the assessment of cognitive ability/intelligence and personality traits. For instance, visual perception speed, coding speed, spatial orientation ability, speech expression ability, operational ability, etc. were assessed for cognitive ability, and personality traits or mental health factors are mainly conducted through the Sixteen Personality Factor Questionnaire (16PF) or the Minnesota Multiphasic Personality Inventory (MMPI). But these tests only contain part of the psychological qualities of airline pilots.[32]

Nevertheless, limited research has examined the relationship between flight cadets' emotional state and flight performance during the training period. Our research group went to the domestic airlines to carry out an investigation. Many

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airlines in China send most flight cadets to foreign aviation schools for training. However, some cadets would be eliminated for various reasons. English communication skills, flight ability, emotional problems, learning attitude, and cultural differences were the key impact factors. Some cadets had to have their training terminated because of emotional problems, which mainly manifested in emotional instability, tension, and anxiety when flying. That emotion or stress can jeopardize decision-making relevance and cognitive functioning, and then affect flight safety.[1]

Emotional intelligence (EI) is a kind of psychological trait for emotion perception, regulation, and application. The concept of emotional intelligence was originally proposed by Salovey and Mayer.[27] A widely adopted definition was "the ability to perceive accurately, appraise, and express emotion; the ability to access and/or generate feelings when they facilitate thought; the ability to understand emotion and emotional knowledge; and the ability to regulate emotions to promote emotional and intellectual growth."[20] EI has been defined and used by researchers in many ways after its introduction. In this study, we adopted the integrated four-dimensional definition of EI proposed by Davies et al. through their comprehensive review and synthesis of the EI literature,[2] which was developed based on the definition of Mayer and Salovey.[20] These four EI dimensions are: 1) appraisal and expression of emotion in one's self; 2) appraisal and recognition of emotion in others; 3) regulation of emotion in one's self; 4) use of emotion to facilitate performance. Many task-related tests were developed based on this definition.[18] Compared with the task-related tests, Wong et al. developed a self-reported scale based on this definition by multiple samples and labeled the instrument the Wong and Law Emotional Intelligence Scale (WLEIS),[30] which was found to have good convergent and discriminant validity for Chinese samples.[18]

There is general consensus that EI is positively related to positive affect and negatively related to negative affect.[16,28] There were also significant correlations between EI and personality factors, for instance, significant positive correlations with agreeableness, extraversion, and negative correlation with neuroticism.[12] Neuroticism or emotional instability is related to being anxious, emotional, angry, and depressed.[3] This overlaps conceptually with the EI dimension of emotion regulation. People who are angry or depressed may have lower levels of emotion regulation.[14] Furthermore, EI is also a strong protective factor in coping with occupational stress and buffers against symptoms of depression and anxiety.[19] A strong association between EI and depression and anxiety has been found among pilots.[7]

According to previous studies, EI can make a meaningful prediction of individual life, work performance, and academic achievement.[9] But there are also studies showing that EI is weakly or even negatively correlated with academic performance.[13,24] In the field of aviation, civil piloting is a complex and special professional vocation which requires strong emotional control ability for pilots.[1] There is a significant correlation between EI and the flight performance of military pilots.[5] Nevertheless, limited research has examined the correlation between flight cadets' emotional intelligence and their flight performance.

Psychological assessment has been used to identify mental illness in the selection of pilots.[15] But emotional state and emotional intelligence, which are very important factors in flight safety and performance, are still rarely studied for the training of flying cadets. Therefore, based on literature review and preliminary survey results from domestic airlines, the current study was intended to provide an exploratory look at the relationship between EI and simulated flight performance (SFP), and investigate the mechanism of emotional state as a mediator in the effect of EI on SFP. If EI or emotional state is an indicator of high performance within successful flight cadets, it could be applied in designing an EI component in flight training to enhance performance.

As described above, EI has been found to negatively relate to the emotional state variables of neuroticism, tension, and anxiety,[7,12,19] which may jeopardize human performance.[1] Therefore, we made the following hypotheses. 1) EI would be negatively associated with emotional state, which is mainly represented as neuroticism, tension, and anxiety. 2) The underlying mechanism of the association between emotional state and flight performance on flight cadets' training is still unclear. Based on previous research, we hypothesized that there would be a negative association between emotional state and SFP. 3) In some cases, EI has been found to positively correlate with performance,[9] but in other cases, there has been no relationship or a negative relationship.[13,24] As such, we hypothesized that EI would positively significantly correlate with SFP under a stressful situation. 4) Because EI had different effects on performance, this makes us believe that emotional state might act as a mediator. Therefore, we hypothesized that EI would have an indirect effect on simulated flight performance through the emotional state variables of neuroticism, tension, and anxiety. **Fig. 1** outlines the hypothesized mediation model. Furthermore, the additional exploratory analyses were conducted to examine these relationships in terms of the EI subscales.

METHODS

Subjects

There were 90 undergraduates, all men, from the School of Aerospace Medicine who took part in the study, ranging in age from 21 to 24 (M = 22.4, SD = 0.67). All of the subjects took part in the simulated flight training and assessment, and the

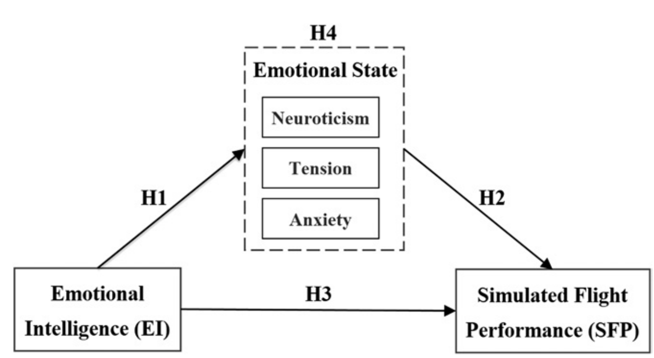

Fig. 1. Hypothesized research model.

investigation of emotional intelligence and emotional state. The study protocol was approved in advance by the Fourth Military Medical University and meets the ethical guidelines.

Materials

Wong and Law Emotional Intelligence Scale. Emotional intelligence was assessed by a Chinese version of the self-report Wong and Law Emotional Intelligence Scale (WLEIS),[30] which consists of 16 brief items. The scale includes four subscales: Self Emotion Appraisals (SEA), Others' Emotion Appraisals (OEA), Use of Emotion (UOE), and Regulation of Emotion (ROE). A sample item from the SEA is "I always know whether or not I am happy." A sample item from the OEA is "I am sensitive to the feelings and emotions of others." A sample item from the UOE is "I always tell myself I am a competent person." A sample item from the ROE is "I am quite capable of controlling my own emotions." The response format of the WLEIS is a 7-point Likert type scale (1 = totally disagree, 7 = totally agree). The WLEIS has good reliability and validity.[16,28] In this study, the Cronbach alpha coefficients for the four subscales were: SEA, 0.921; OEA, 0.875; UOE, 0.898; and ROE, 0.885. The Cronbach alpha coefficient for all 16 items was 0.912. For consistency of interpretation, higher scores on all dimensions indicate higher levels of EI.

Neuroticism scale. The neuroticism scale is derived from a Chinese adaptation of the Eysenck Personality Questionnaire Revised (EPQ-R),[3] which has good reliability and validity with Chinese populations (using a forced-choice 'Yes/No' response scale).[22] Neuroticism reflects reactivity of the autonomic nervous system with those high in neuroticism displaying higher reactivity and, therefore, less emotional stability. Personality traits associated with neuroticism include being highly anxious, moody, and tense. Sample items include "Does your mood often go up and down?" "Do you ever feel 'just miserable' for no reason?" The Cronbach alpha coefficient of the neuroticism scale in the present study was 0.876, which was similar to previous studies.[22] Higher scores represented less emotional stability.

State Anxiety Inventory. The State Anxiety Inventory (SAI) is derived from the Chinese version of Spielberger's State-Trait Anxiety Inventory (Form Y; STAI-Y), which is widely used in China.[33] State anxiety is measured with 20 items and is characterized by feelings at the moment. On a 4-point scale ranging from 1 = not at all to 4 = very much so, respondents are asked to indicate how they feel about themselves at the time of assessment. Sample items include "I am tense," "I feel upset," "I feel nervous," and "I feel content" (reverse coded). The Cronbach alpha coefficient for the State Anxiety Inventory in this study was reported as 0.934. The total score represents the general level of anxiety, with higher scores indicating more anxiety.

Tension scale. To assess tension, the Profile of Mood States (POMS) questionnaire submitted to the subjects was a Chinese version which has been widely used in China.[11] This questionnaire consists of six subscales, of which the tension scale was used in this study. The tension subscale consists of nine single word items: tense, on edge, uneasy, restless, nervous, anxious, et al. Respondents indicate how much they have felt like the word (0 = not at all; 1 = a little; 2 = moderately; 3 = quite a bit; 4 = extremely). Higher scores indicate that subjects have higher tension symptoms. The Cronbach alpha coefficient of the tension scale was 0.821 in this study.

Flight training simulator. The Type-6 Primary Trainer is an aircraft designed and built in China, with a nose wheel and two seats, meant to conduct simulated flight training for flight cadets or other flight enthusiasts as a basic trainer. The simulator can simulate a variety of flight subjects, such as traffic pattern flight, daylight instrument flight, night instrument flight, formation flight, aerobatic flight, etc. This study was performed using the simulator of the Type-6 Primary Trainer. Due to the limitations in training time, traffic pattern flight was chosen for the main training subject. This refers to the aircraft flying around the airport according to the scheduled flight route and strictly maintaining the specified altitude and speed. It is the foundation of all flight activities. Procedures of traffic pattern flight contain taxiing along the runway, takeoff, lift-off and climbing, level flight, landing, etc.

Procedures

Simulated flight training. Simulated flight training is a compulsory course for aerospace medicine students, who will learn flight theory and simulated flight practice in this training. In order to ensure that each student has sufficient time to practice, we adopted a small-size class teaching. There were 90 students who were divided into 8 groups, with 12 persons in each group (6 in the last group). Two students shared a flight simulator in the course so they could take turns operating it and discussing it with each other. An experienced retired flight instructor taught the students. The simulated flight training consisted of three stages: 1) learning the cockpit control equipment, commonly used instruments, and indicator equipment, to which attention should be paid during the flight process; 2) mastering four basic flight actions—"level flight," "climbing," "gliding," and "turning."; and 3) conducting traffic pattern flight training—this stage had to ensure that students were proficient in the whole flight course independently. Each stage lasted 3 h. The whole simulated flight training complied with the PT-6 aircraft pilot's flight manual. If students experienced any problems during flight training, they could consult the instructor at any time.

Simulated flight assessment. In the 20 min before the SFP assessment, the WLEIS, neuroticism scale, SAI, and tension scale were given to all 90 students, who answered the items anonymously and were informed that the results of the scales were not related to SFP. After that, we conducted the simulated flight assessment for each student, during which three students were tested on separate flight simulators at the same time.

Five instructors (a flight instructor and four experienced simulated flight instructors) evaluated students' SFP. Evaluation indicators included taxiing, takeoff, flight attitude, flight profile, and landing. Each indicator was explained as follows:

- Taxiing: to evaluate whether students could start the flight simulator correctly and maneuver the aircraft at the proper taxiing speed and direction.
- Takeoff: to evaluate the angle of attack, speed, the rate of climb, and flight direction when the aircraft started to take off.
- Flight attitude: to assess whether students maneuvered the rudder gently and the degree of mastery of the four basic flight actions "level flight," "climbing," "gliding," and "turning."
- Flight profile: this is a function of the simulator to assess whether the traffic pattern complied with the scheduled flight path.
- Landing: to evaluate the descending rate, the downward direction during touching down, and whether the student landed in the airport safely.

The Delphi Experts Grading Method was used to gather expert opinion on students' SFP, which was identified as a potentially suitable option. A Delphi technique is a method for gathering opinions from different experts. The use of group grading overcomes limitations of the test that may be due to the particular bias of the individual designers.[8] This will ensure content validity, reliability and consistency of the tool, and ensure the accurate assessment of everyone's flight performance. According to the flight instructor's experience and the difficulty level of the simulation flight, the weight coefficients of the five evaluation indicators were determined to be equal to 0.2. **Table I** illustrates the valuation method of SFP. The calculation formula of the SFP is:

$$SFP = \sum_{i=1}^{5} AiWi,$$

where *SFP*: the comprehensive of five evaluation indicators; *Ai*: weight coefficient of the evaluation indicator "i"; and *Wi*: the score of the evaluation indicator "i".

Statistical Analysis

Descriptive statistics and Pearson correlations among all variables were analyzed using SPSS 23.0. The simple and multiple mediation models were both executed using the PROCESS macro for SPSS.[10] The sample of bias-corrected bootstrap confidence intervals (CI) was set to 10,000 to calculate the 95% confidence interval of the indirect effect. Regression weights were all unstandardized coefficients. Kendall's coefficient of concordance (W) was used to assess the reliability for the five experts, which is a measure of the agreement among several judges who are assessing a given set of *N* objects. The Kendall's W coefficient has been applied to many different situations. Kendall's W statistic is a nonparametric test method, which is an estimate of the variance of the row sums of ranks divided by the maximum possible value the variance can take; this occurs when all judges are in total agreement; hence $0 \leq W \leq 1$. Friedman's Chi-squared statistic was used to test W for statistical significance. When the *P*-value of the Chi-squared test is less than 0.05, it means that the evaluation results of *N* judges have high consistency.[6]

RESULTS

As shown in **Table II**, the coefficients of W were all greater than 0.4 for each indicator, and the comprehensive SFP was above 0.6. The results of the Chi-squared test are listed in Table II, which presents $P < 0.001$ for all the indicators. Therefore, there was good consistent reliability among the five raters on students' SFP. Intercorrelations of these indicators were moderate and correlations between each indicator and SFP were moderate or high, which indicates good discriminant validity. So SFP score can effectively represent the simulated flight performance of each participant.

Table III presents mean scores, standard deviations, Cronbach alpha coefficients, and Pearson correlations for all study variables. Correlation of each variable was analyzed to secure the discriminant validity and avoid multicollinearity. Usually the variance inflation factor (VIF) is used to determine multicollinearity and a VIF of 5 or 10 and above indicates a multicollinearity problem.[23] As shown in Table III, values of the correlation coefficient among variables were moderate or low, and VIF of these variables were all less than 5. These indicated no evidence of multicollinearity. In this study, the Cronbach alpha coefficient for each subscale was greater than 0.8, which indicated that the test scale has good internal consistency and reliability. As predicted, EI was negatively correlated with neuroticism ($r = -0.31$, $P = 0.003$), tension ($r = -0.31$, $P = 0.003$), and anxiety ($r = -0.31$, $P = 0.003$). Generally, the higher the EI scores, the lower the neuroticism, tension, and anxiety scores. Therefore, hypothesis 1 was supported. However, there were no significant relationships between the emotional state variables and SFP, so hypothesis 2 was not supported. Except that UOE was significantly correlated with SFP ($r = -0.25$,

Table I. The Evaluation Form of Simulated Flight Performance.

		EVALUATION GRADE							
		EXTREMELY GOOD	GOOD	A LITTLE GOOD	MEDIUM	A LITTLE BAD	BAD	EXTREMELY BAD	
INDICATOR	WEIGHT	1.0	0.8	0.6	0.5	0.4	0.3	0.1	SCORE
Taxiing	0.2		√						0.16
Takeoff	0.2			√					0.12
Flight attitude	0.2			√					0.12
Flight profile	0.2				√				0.1
Landing	0.2					√			0.08
SFP	1								0.58

SFP: simulated flight performance.

Table II. Results of Correlation Analysis and Reliability Test.

INDICATORS	M	SD	KENDALL'S *W*	*P*	2	3	4	5	6
Taxiing	0.94	0.09	0.40	$<$0.001	0.49***	0.21*	0.24*	0.23*	0.48***
Takeoff	0.88	0.10	0.45	$<$0.001		0.58***	0.51***	0.45***	0.74***
Flight Attitude	0.79	0.13	0.53	$<$0.001			0.73***	0.63***	0.84***
Flight Profile	0.74	0.16	0.71	$<$0.001				0.70***	0.88***
Landing	0.73	0.16	0.57	$<$0.001					0.84***
SFP	0.82	0.10	0.69	$<$0.001					

SFP: simulated flight performance.
* $P < 0.05$, *** $P < 0.001$.

$P = 0.018$), there were no significant associations between other subscales and SFP. Associations between study variables and SFP are further analyzed below.

We then analyzed the mediating effect of neuroticism, tension, and anxiety, respectively, in the relationship between EI and simulated flight performance. Before the analysis of mediating effects, the applicable conditions of the regression models were tested, and the linearity and homoscedasticity between study variables all met the relevant requirements. 1) The test of indirect effects of neuroticism showed the mediating effect was not significant (B = 0.005, SE = 0.004, 95% CI = −0.001 to 0.016). The confidence interval contained zero, indicating that there was no significant mediating effect of neuroticism in the relationship between EI and SFP. And the direct effect of EI on SFP was also not significant (B = −0.018, $t = -1.47$, $P = 0.144$). 2) Bootstrapping results indicated that the indirect effect of tension was significant (B = 0.008, SE = 0.004, 95% CI = 0.002 to 0.02), which confirmed a significant mediating effect of tension on the relationship between EI and SFP. However, the direct effect of EI on SFP was not significant (B = −0.02, $t = -1.77$, $P = 0.08$). 3) Bootstrapping results indicated that the indirect effect of anxiety was significant (B = 0.008, SE = 0.005, 95% CI = 0.001 to 0.02), which indicated a significant mediating effect of anxiety on the relationship between EI and SFP. But the direct effect of EI on SFP was not significant (B = −0.02, $t = -1.73$, $P = 0.088$). 4) To test whether the three emotional state variables for meaning functioned as mediators between EI and SFP, we conducted multiple mediation, which permits the assessing of multiple indirect effects simultaneously.[25] The total indirect effect for all three mediators assessed simultaneously was significant (B = 0.01, SE = 0.006, 95% CI = 0.001 to 0.025); however, the total direct effect had no statistical significance (B = −0.023, SE = 0.012, 95% CI = −0.047 to 0.001). We then examined the mediators individually and found that the confidence intervals for the effect size of the indirect path through tension (B = 0.0052, 95% CI = −0.004 to 0.019), anxiety (B = 0.0038, 95% CI = −0.005 to 0.018), and neuroticism (B = 0.001, 95% CI = −0.006 to 0.011) all included zero. But relatively, the emotional state for tension showed a stronger effect than the others. Generally, EI influences SFP via emotional states, especially tension and anxiety. The higher the EI score, the lower the tension and anxiety scores, and tension and anxiety have significant effects on SFP. Therefore, except for neuroticism with no significant effect on SFP, hypothesis 4 was supported. Because there was no significant direct effect of EI on SFP, hypothesis 3 was not supported.

To further assess the effect of EI on SFP, we examined whether the mediating effect of emotional states differed at certain levels of SEA, OEA, UOE, and ROE. As shown in **Table IV**, the indirect effect of SEA on SFP via tension indicated that the relationship between SEA and SFP was meditated by tension (B = 0.005). Similarly the relationship between ROE and SFP was also meditated by tension (B = 0.008). However, the indirect effects of UOE on SFP via neuroticism (B = 0.002), tension (B = 0.002), or anxiety (B = 0.002) were not significant. Conversely, the direct effects of UOE on SFP were significant, indicating that the relationship between UOE and SFP was not meditated by emotional state. We conducted multiple mediation to assess multiple indirect effects simultaneously between EI and SFP. There were no significant indirect effects for all three mediators on the relationship between subscales and SFP. However, only the direct effect for UOE had statistical significance (B = −0.023). Therefore, SEA and ROE may influence SFP via tension, while UOE has direct effect on SFP without any mediating effect by emotional state.

DISCUSSION

The results indicated that SFP scores could represent each student's level of simulated flight performance properly, and the whole simulated flight training was effective. As we expected,

Table III. Means, Standard Deviations, Alphas, and Intercorrelations of Study Variables.

VARIABLES	M	SD	α	2	3	4	5	6	7	8	9
SEA	5.38	1.32	0.92	0.44***	0.40***	0.46***	0.78***	−0.28**	−0.32**	−0.30**	0.03
OEA	4.91	1.23	0.88		0.50***	0.23*	0.72***	−0.03	−0.07	−0.07	−0.16
UOE	4.79	1.22	0.90			0.50***	0.79***	−0.16	−0.11	−0.11	−0.25*
ROE	4.65	1.18	0.89				0.72***	−0.48***	−0.44***	−0.45***	0.01
EI	4.93	0.93	0.91					−0.31**	−0.31**	−0.31**	−0.12
Neuroticism	8.47	5.49	0.88						0.47***	0.48***	−0.09
Tension	10.29	5.71	0.82							0.68***	−0.18
Anxiety	42.32	10.95	0.93								−0.17
SFP	0.82	0.1	0.82								

SEA: self emotion appraisals; OEA: others' emotion appraisals; UOE: use of emotion; ROE: regulation of emotion; EI: emotional intelligence; SFP: simulated flight performance.
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table IV. Mediation Effects of Emotional States, Respectively.

MEDIATING VARIABLES & SUBSCALES	DIRECT EFFECT			INDIRECT EFFECT		
	EFFECT	SE	95%CI	EFFECT	SE	95%CI
Neuroticism						
SEA	0.001	0.009	−0.016, 0.017	0.002	0.003	−0.002, 0.01
OEA	−0.013	0.009	−0.031, 0.004	0.0002	0.001	−0.002, 0.004
UOE	**−0.023**	**0.009**	**−0.04, -0.005**	0.002	0.002	−0.001, 0.008
ROE	−0.003	0.01	−0.024, 0.017	0.005	0.005	−0.004, 0.016
Tension						
SEA	−0.002	0.009	−0.019, 0.015	**0.005**	**0.003**	**0.000, 0.013**
OEA	−0.014	0.009	−0.031, 0.003	0.001	0.002	−0.002, 0.007
UOE	**−0.023**	**0.008**	**−0.039, -0.006**	0.002	0.002	−0.001, 0.008
ROE	−0.007	0.01	−0.027, 0.013	**0.008**	**0.005**	**0.000, 0.019**
Anxiety						
SEA	−0.001	0.008	−0.018, 0.015	0.004	0.004	−0.005, 0.014
OEA	−0.014	0.009	−0.031, 0.003	0.001	0.002	−0.002, 0.008
UOE	**−0.023**	**0.008**	**−0.039, -0.006**	0.002	0.002	−0.001, 0.007
ROE	−0.007	0.01	−0.027, 0.014	0.008	0.005	−0.001, 0.019
Multiple mediators†						
SEA	−0.003	0.009	−0.02, 0.015	0.005	0.004	−0.001, 0.017
OEA	−0.014	0.009	−0.032, 0.003	0.001	0.003	−0.003, 0.008
UOE	**−0.023**	**0.009**	**−0.04,-0.006**	0.003	0.003	−0.002, 0.009
ROE	−0.009	0.011	−0.031, 0.012	0.011	0.007	−0.002, 0.024

SEA: self emotion appraisals; OEA: others' emotion appraisals; UOE: use of emotion; ROE: regulation of emotion.
Bold numbers represent statistical significance at the confidence level 95%.
† Neuroticism, tension, and anxiety were analyzed simultaneously as mediators between emotional intelligence and simulated flight performance.

correlational results from the current study showed that EI had a significant relationship with neuroticism, tension, and anxiety. These results were consistent with earlier studies that reported relationships between EI and emotional states.[16,28] It is suggested that students with low self-perception of EI were more prone to experience neuroticism, tension, and anxiety. Furthermore, tension and anxiety were negatively correlated with SEA and ROE, respectively. Obviously, people with the stronger self-emotional perception ability were able to perceive their own emotional state properly. And good emotional regulation ability could help to reduce the level of negative emotion. Moreover, there were negative correlations between SFP and neuroticism, tension, and anxiety, but no significance. We assumed that the correlations between SFP with emotional state may be affected by EI. Furthermore, UOE may have a negative effect on SFP. That is, the students who had higher ability to use emotion may have had lower SFP, which was inconsistent with most previous studies.[9] Also, some prior researches indicated that there were negative or very low correlations between EI and cognitive ability or academic achievement.[13,24] We need to further analyze the relationship among EI subscales, emotional state, and SFP, and we may find the answers.

Mediation analyses indicated that the effect of EI on SFP was mediated by tension and anxiety, respectively. Because the SFP would affect students' final academic achievement, the simulated flight assessment had caused some emotional fluctuations to them. They would feel stressed or anxious before or during the assessment. Our findings demonstrated that tension and anxiety were negatively correlated with SFP significantly, respectively, when the EI score was controlled, which indicated that anxiety and tension had affected students' SFP. Through the analysis of mediating effects, the results revealed that EI may perceive and regulate the level of tension and anxiety to improve flight performance. In addition, the mediating effect of neuroticism was not significant. Neuroticism is a relatively stable personality trait which represents students' constant behavioral tendencies. This trait does not change with assessment contexts. Therefore the simulated flight assessment situation did not affect students' neuroticism, which is in accordance with our results. We also found significant multiple indirect effects for the three emotional state variables assessed simultaneously, which indicates EI influences SFP via emotional state, especially tension and anxiety. We know that extreme nervousness would jeopardize decision-making ability, as well as the fundamental maneuvering and basic flying skills of pilots so as to endanger flight safety,[1] especially for flight cadets. This study confirmed that conclusion. Therefore, we could improve cadets' EI through selection or training to improve their emotional state and enhance flight safety. However, which factors of EI are more influential requires further analysis on the effect size of each subscale.

The results supported previous findings that emotional state was associated with performance.[1] It is suggested that SEA or ROE affects SFP, mediated by tension. The result indicated that SEA and ROE may significantly contribute to diminish students' tension, which helps to maintain a good emotional state and then improve their simulated flight performance. According to EI theory, SEA relates to an individual ability to understand their deep emotions and be able to express them naturally. Students who had high ability in this area would sense and acknowledge their emotions well. And ROE relates to the ability of students to regulate their emotions, thus enabling a more rapid recovery from emotional climax and distress. Students who had high ability in this aspect were able to keep their behavior under control when they had extreme moods.[2,27,30] So students with high SEA and ROE may regulate their emotional state to a proper level, which optimizes SFP. Therefore, selection criteria for civil pilots should require excellent psychological qualities and a stable emotional state. Presumably it is necessary to develop EI training strategies, especially for SEA and ROE, to keep a good emotional state and then improve flight performance during flight training. These findings may also help to explain why EI did not significantly correlate with academic achievement and work performance among students or workmen.[13,24] Emotional state could mask the effect of EI on performance.

In addition, the failure to obtain the predicted association between UOE and SFP is surprising given the theoretical underpinnings of the prediction, derived from the conceptual models of EI.[2,27,30] We know that UOE relates to the ability of a person to make use of their emotions by directing them toward constructive activities and personal performance. A person with great ability in this area maintains positive emotions most of the time. They make full use of their emotions to facilitate high performance in the workplace and their personal lives.[30] This definition of UOE contradicted our results, for which there may be several possible reasons. 1) The inconsistent effects of students' ability to use emotions point to the relevance of the situation for EI effects: SFP was assessed under time pressure, which represented a stressful situation. Each student had just one chance to take the simulated flight assessment, of which the performance would directly determine their final academic achievement. This situation may make students feel stressed and nervous, which was similar to the tremendous time and stress of real flight training. However, there is a best motivation level for any task under a stressful condition. Once the motive strength exceeds this level, it may reduce the task performance.[26] We believe that students with high ability to use emotions might achieve good flight performance under increased achievement motivation, which was consistent with the emotional intelligence ability model proposed by Mayer and Salovey.[20] However, excessive motivation might jeopardize flight performance under such a stressful situation. 2) UOE may lead to emotional exhaustion.[21] More specifically, some research has indicated a great ability in the UOE dimension of EI might lead to burnout (emotional exhaustion),[29] which could jeopardize job performance.[21] Similar to the results of this study, students' strong ability to use emotions might lead to emotional exhaustion under the stressful situation, and then reduce their simulated flight performance. 3) Wong at el. also found very weak or even zero correlations between UOE and job performance.[18,30] It is also surprising that high EI was correlated with poorer performance or academic achievement.[4,24] Therefore, that is a very interesting phenomenon and there may be other factors regulating the relationship between UOE and SFP, especially under the stressful situation. Further efforts in this direction should be encouraged.

The present study has several limitations that require mentioning. Firstly, since the results of psychological evaluations may have social desirability effects, these may have been obstacles that inevitably influenced the results.[17] Furthermore, the psychological investigation was conducted in the 20 min before the flight assessment. Although it was emphasized that the results of the investigation had nothing to do with flight assessment and was only for scientific research, the students may still have tended to deliberately disguise or fake "good" for the investigation. Secondly, given the results are based on a cross-sectional survey, the findings are restricted to correlations and cannot infer causal relationships. Further studies should be performed to compare flight performance before and after the flight assessment, to examine different effects of EI and emotional state on flight training performance. Lastly, students' emotional states were induced in the laboratory. It would have been beneficial to have asked students if they felt increased tension and anxiety from testing, which would further verify the reliability of the results. Furthermore, all the participants in this study were aerospace medicine students, not student pilots. In real flight training, due to the influence of high altitude, high speed, noise, vibration, and other factors, students will experience more drastic emotional changes. Thus this simulation flight training experiment limited the generalizability of our findings with regard to real flight training.

Limitations notwithstanding, the present study has provided knowledge on the association between EI, emotional state, and flight performance under a simulated flight situation, showing that EI may affect flight performance via emotional state, especially tension. Moreover, excessive motivation in the stressful situation may reduce flight performance. Future studies will be necessary to study the relationship between EI, emotional state, and flight performance among flying cadets, and which variables should be considered, e.g., sex, personality traits, and mental health of cadets, and also some environment variables. In addition, we are looking forward to conducting a longitudinal study to examine the direct and indirect effects of EI and emotional state on flight performance. Studies with more representative and diverse samples also should be performed to examine whether the internal mechanism linking EI, emotional state, and flight performance can be generalized to other occupational groups. However, this study contributes to the existing body of knowledge on the relationship between EI, emotional state, and flight training performance. The findings of the study also provide practical implications that selection assessment and training of EI may contribute to commercial flight cadets' training.

In summary, through the simulation of the cadets' flight training in the laboratory, this study has emphasized the correlation among EI, emotional state, and simulated flight performance, and the possible causal relationship in which EI had an impact on simulated flight performance through emotional state. The findings allowed us to describe three profiles. 1) There was a significant correlation between EI and emotional state, which mainly manifested through SEA and ROE, which were significantly associated with neuroticism, tension, and anxiety, respectively. 2) UOE had a negative effect on SFP without the mediating role of emotional state. Excessive learning motivation may reduce flight training performance. 3) Emotional state has a mediating effect on the relationship between EI and SFP, indicating that EI affected simulated flight performance through emotional state, especially for tension. It is mainly shown that SEA and ROE affected SFP through tension. So these findings emphasized emotional intelligence may directly or indirectly affect simulated flight performance, and tension played an important mediating role.

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