# Anticipated Negative Emotions Effect on Incident Involvement Among Civil Pilots

Hongwei Wang; Quan Xu; Can Yang; Xiong You; Ming Ji

**INTRODUCTION:** Human factors have contributed to a constant increase in the level and numbers of aviation incident involvement. The primary objective of this study is to investigate the relationships between anticipated negative emotions (ANEs) and incident involvement among Chinese civil pilots. Furthermore, this paper examines the role of risk perception and proactive coping within the relationships in order to understand the mechanisms underlying pilots' involvement in air transport incidents.

**METHODS:** A cross-sectional regression design was used to measure ANEs (Anticipated Negative Emotions Scale), proactive coping (Proactive Coping Scale), risk perception (Pilot Risk Perception Scale), and incident involvement (Hazardous Events Scale) among 295 Chinese civil pilots from China Southern Airlines. Mediation and moderating effects were explored using regression analyses and were confirmed by the bootstrapping approach.

**RESULTS:** The results show that ANEs are significantly correlated with risk perception ($r = -0.55$) and incident involvement ($r = 0.28$). ANEs have a direct effect on pilot involvement in incidents and have an indirect effect on pilot incident involvement through the influencing of risk perception. Proactive coping was also found to weaken the direct effect of anticipated negative emotions on incident involvement.

**DISCUSSION:** The safety benefits of proactive coping are more pronounced among pilots with high levels of ANEs. The practical implications of the study include recommendations relating to injury prevention efforts in incident involvement. Future research directions are also discussed.

**KEYWORDS:** pilots, anticipated negative emotions, risk perception, proactive coping, incident involvement.

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It is commonly acknowledged that human factors have contributed to a constant increase in the level and numbers of aviation accidents.[32] However, not every human act or error will lead to a final accident. Like the tip of the iceberg, accidents are just the most visible part of a much larger body of events that do not lead to disaster for various reasons. The real hidden danger is incident involvement.[17] Hazardous events can be labeled as 'accident precursors' in many settings and can, therefore, be used as the indicators of the safety status of a system or individual;[12] for example, pilots become disoriented in determining their location, so they have to call air traffic conrol (ATC) for assistance. Therefore, many researchers involved in incident involvement have focused on researching the prevalence of hazardous events in aviation and have tried to identify the factors that may be involved in hazardous events.

Some studies based on hazardous aviation events have shown that the cognitive components affecting pilot incident involvement include a general cognitive process,[28] situational awareness,[9] and situational judgment.[19,20] Other studies have demonstrated that a pilot's individual personality traits (e.g., conscientiousness,[25] sensation-seeking,[8] and perfectionism[20]) may have had a direct effect on their involvement in aviation incidents. Indirect effects, through the influence of social cognitive factors (e.g., attitude to hazards, risk perception, and

From the School of Geospatial Information, People's Liberation Army of China (PLA) Information Engineering University, Zhengzhou, Honan Province, China; the Flight Safety Research Institution, People's Liberation Army of China (PLA) Aviation University of the Air Force, Shaanxi Provincial Key Laboratory of Behavior and Cognitive Neuroscience, Xi'an, Shaanxi, China; the School of Psychology, Shaanxi Normal University, Xi'an, Shaanxi, China; and the Shaanxi Provincial Key Laboratory of Behavior and Cognitive Neuroscience, Xi'an, Shaanxi, China.

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Address correspondence to: Ming Ji, Ph.D., School of Psychology, Shaanxi Normal University, Yanta Campus: No. 199, South Chang'an Rd, Yanta District, Xi'an, Shaanxi 710062, China; jiming@snnu.edu.cn.



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perceived behavioral control), are also frequently related to these traits.[22,23,35] However, some studies conclude that most aviation safety campaigns, which are based on cognitive components, personality traits, and social cognition, have not significantly reduced the number of accidents or incidents.[27]

One important reason for the latter may be that the role of emotional factors has often been overlooked with regard to aviation safety campaigns. Pilots often encounter stressful events that require them to make immediate decisions under intense time pressure and demanding workloads. These stressful events frequently occur in dynamic situations. In such cases, pilots will typically have certain expectations (based on previous events) when they are assessing the stressful events to be faced in the future. It is these expectations which induce emotions for the future-orientation (i.e., the emotional response) to the future events. Therefore, anticipated emotion may exert a strong impact on an individual's level of information processing and behavior, especially when faced with an environment that is uncertain, highly pressurized, and characterized by high task complexity.[15] Another reason why the indirect effect of emotional factors might be underestimated in relation to accident and incident involvement is because an individual's cognitive processing and assessment of the environment is affected by his or her emotions.[1,5] As an individual response to anticipated future events, any future-oriented coping behavior may be directly related to a pilot's previous incident involvement. Pilots anticipate or detect potential stressful situations and take advance action to prevent the situation from escalating or occurring in the first place, thereby negating the effects. However, no research to date has formally tested the relationship between previous pilot incident involvement and future-oriented coping behavior when faced with similar incidents.

In this study, we empirically examine the following questions. 1) Are anticipated negative emotions (ANEs) associated with pilot incident involvement? 2) Do ANEs have an indirect effect on incident involvement through risk perception? 3) Does proactive coping have a moderating effect in the relationship between ANEs and incident involvement? To answer these questions, we test the model shown in **Fig. 1**. The following section describes the theoretical background of the study.

As future-oriented emotions, ANEs are comprised of negative feelings that might be experienced after a certain action or inaction in confronting future events.[4] Specifically, ANEs refer to an individual's sadness about possible adverse events in the future. These emotions are expressed in the forms of worry, anxiety, tension, restlessness, or stress.[30] Many studies have found that ANEs influence decision making and behavior in a broad variety of contexts (e.g., in business,[15] physical exercise,[31] and purchase decisions[2]). Researchers have found that individuals will engage in certain behaviors to eliminate the negative feelings caused by the expected negative consequences. For example, a study found that the ANEs caused by not regularly taking part in physical activity will encourage individuals to participate more in physical exercise.[31] Another study found that ANEs have a positive and significant influence on the transition from start-up intentions into actions. Entrepreneurs with high levels of ANEs will be more likely to regulate their behavior and more likely to proceed to the business gestation phase of a project.[15]

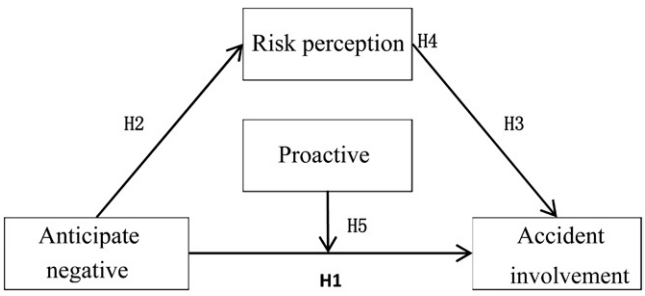


**Fig. 1.** Model of the incident involvement.

However, piloting is a special, professional, and complex vocation, performed in high-risk and stressful situations. As such, pilots are more susceptible to emotions.[1] Studies examined the impact of strong negative emotional consequences, induced by economic pressure, on plan continuation errors (PCE).[5,6] A PCE is a well-known error made by pilots that consists of "failure to revise a flight plan despite emerging evidence that suggests the existing flight plan is no longer safe."[29] The study concludes that, when a pilot anticipates that a "go-around" (i.e., aborting a landing and circling to make another landing attempt) will bring huge losses (e.g., fuel consumption) to the airlines, the pilot's anticipation will generate strong negative emotions. These emotions will prompt the pilot to continue with the initial attempt to land, despite unfavorable landing conditions (e.g., adverse weather), thus causing incident involvement. In addition, pilots experiencing more social pressure to deliver passengers on time are more likely to continue to change from flying using visual flight rules (VFR) to using instrument meteorological conditions (IMC).[3] This also reflects pilots' anticipated stress and the negative emotional consequences of failing to deliver passengers on time, thus prompting the pilots to take risks. Based on these findings, it can be concluded that the expected negative emotional outcomes will lead to greater risk behaviors and incidents for pilots. Thus, we hypothesize that: H1. ANEs will positively predict pilot involvement in incidents.

Risk perception is conceived as a primarily cognitive activity, one that can discern the risk associated with a situation or hazard, and which involves the accurate appraisal of an external situation, as well as the perceiver's personal capacities.[17] Underestimating an external situation and overestimating one's own personal capacity can lead to a misperception of the risk. This is frequently seen as a factor in aircraft accidents. Therefore, risk perception is a crucial skill for a pilot to have in order to identify and cope with hazardous in-flight situations. However, ANEs may affect an individual's assessment of environmental risks. The negative anticipation of future events can increase an individual's stress and mental load. A study of pilots flying while under intense pressure shows that the anxiety caused by that pressure can negatively influence pilots' attention spans and gaze behavior, thereby negatively affecting pilots' perceptions of

environmental information.[1] Thus, both theory and empirical evidence lead to the following hypothesis: H2. ANEs will negatively predict pilot risk perception.

Furthermore, risk perception has been suggested as an explanation for behavior by pilots that results in incidents and accidents.[17] Pilots who do not accurately perceive inherent risks in a situation might not undertake avoidance or other risk-mitigating actions. The results of these misperceptions are incidents or accidents. And a significant negative correlation ($r = -0.123$) exists between incident involvement and situations in which pilots rate the level of perceived risk that applies to oneself.[19] Similarly, a study surveyed 275 army helicopter pilots and found that pilots who perceive a risk to be low will exhibit higher risk-taking tendencies than those pilots who perceive a risk to be high.[24] In addition, in studies of pilot risk perception based on Chinese cultural background, researchers have found that risk perception positively predicts the level of pilot safety operation behavior.[23,35] Consequently, our third hypothesis is as follows: H3. Risk perception will negatively predict pilot involvement in incidents.

As noted earlier, ANEs directly influence risk perception and risk perception directly influences pilot involvement in accidents. Therefore, ANEs may indirectly affect pilot involvement in incidents through the ANEs' influence on risk perception. Based on this, we extend the logic of Hypotheses 2–3 and posit the following prediction: H4. Risk perception will mediate the relationship between ANEs and pilot involvement in incidents.

Proactive coping is defined as "an individual's efforts to build up the general resources that facilitate promotion toward challenging goals and personal growth."[11] Proactive coping is the latest supplement to the positive aspect of coping research. While traditional coping conceptions target stressful events that have occurred or are occurring, proactive coping is aimed at coping with stressful events that may happen in the future. Consequently, as a more active and future-oriented coping strategy,[11] proactive coping can affect pilots' situational judgment and decision-making skills.[21] Meanwhile, extensive research has found that proactive coping can alleviate stress and promote positive psychological outcomes. It is documented that there are significant negative correlations between anxiety and proactive coping. Higher levels of proactive coping are associated with lower levels of anxiety.[26] A study of pilots' mental health has also found that proactive coping has protective effects with regard to civil pilots' depression and anxiety.[13] Consequently, this study suggests that ANEs' effects on pilot involvement in incidents may be affected by proactive coping, and we make the following assumptions: H5. Proactive coping will moderate the relationship between ANEs and pilot involvement in incidents.

## METHODS

### Subjects

A paper-and-pencil survey was administered to 295 experienced male commercial airline pilots, all of whom were recruited from China Southern Airlines Ltd. The pilots' ages ranged from 23 to 51 yr ($M = 31.43$, $SD = 6.73$) and their total flight hours ranged from 920 to 46,400 ($M = 13{,}800$, $SD = 9547.03$). All subjects participated in this study on a voluntary basis. The study protocol was approved in advance by the ethics committee of Shaanxi Normal University and meets the ethical guidelines.

### Materials

***Anticipated Negative Emotions Scale.*** Similar to previous studies,[15,31] ANEs were measured by asking the participants to predict the feelings that might occur in the event of not performing the following behavior, as follows: "Thinking about a future scheduled flight, not being able to control the aircraft in such a way as to arrive at the destination airport on time, due to adverse flight conditions, would make me feel..." The sentence was followed by four options, each of which describes a different negative emotion: "Disappointed/Annoyed/Regretful/Angry." Participants were asked to rate their level of agreement with each emotion from 1 (strongly disagree) to 7 (strongly agree). A high score on the scale indicated a higher level of ANEs. The coefficient $\alpha$ for this scale in the present study is 0.94.

***Risk Perception Scale.*** Risk perception was measured using a 26-item scale developed by Hunter[19] which assesses a pilot's perception of risk to self. The 26 items were presented as scenarios, of which 19 related to flight activities, such as, "At night, fly from your local airport to another airport approximately 150 miles away, in a well-maintained aircraft, when the weather is marginal VFR (3-mile visibility and 2000-ft overcast)." The remaining scenarios are concerned with driving and daily life. They include statements such as, "Drive your car on a freeway near your home, during the day, at 65 MPH in moderate traffic, during heavy rain." The scale contains five factors: 1) general flight risk (five items), 2) high flight risk (seven items), 3) altitude risk (seven items), 4) driving risk (three items), and 5) everyday risk (four items). Participants were asked to rate their perception of the risk of each scenario on a scale from 1 to 100, where 1 = low risk and 100 = high risk. The respondents were told to answer as if they were going to be involved in that scenario the next day. A high score on the scale indicates a high level of risk perception. The coefficient $\alpha$ for this scale in the present study is 0.88.

***Proactive Coping Scale.*** Proactive coping was measured with the Chinese validated version of the Proactive Coping Scale.[11] The scale consists of eight items. A representative item would be, "I plan my strategies to change a situation before I act." Participants rated each item on a 6-point Likert scale, ranging from 1 (strongly disagree) to 6 (strongly agree). A high score on the scale indicates a high level of proactive coping. The coefficient $\alpha$ for this scale in the present study is 0.84.

***Hazardous Events Scale.*** Incident involvement was measured using a 10-item Hazardous Events Scale (HES) adapted from

Hunter.[18] This scale was used to assess the number of times a pilot had experienced a hazardous in-flight event during the preceding 24 mo. For example, one statement was in the form of the question, "How many times have you run so low on fuel that you were seriously concerned about making it to an airport before you ran out?" Another was, "How many times have you become so disoriented that you had to land or call air traffic control for assistance in determining your location?" Participants were asked to respond to the items on a 6-point Likert scale, ranging from 0 (none) to 5 (more than four times). Higher scores on this scale imply a higher level of incident involvement. The coefficient α for this scale in the present study is 0.68.

### Statistical Analysis

In this study, SPSS 22.0 (IBM, Armonk, NY, USA) and Amos 21.0 (IBM) were used for data analyses. Cronbach's alpha coefficient was used to evaluate the internal consistency of each measure. A structural equation analysis was performed using Amos 21.0 to examine whether or not ANEs have a significant effect on incident involvement and whether risk perception mediates the hypothesized effect of ANEs on incident involvement. The moderating effects of proactive coping on the relationship between ANEs and involvement in incidents were estimated via a hierarchical regression analysis using SPSS 22.0. A confirmatory factor analysis (CFA) was used to evaluate the relational model and the fit of the risk perception subscales to their respective latent constructs. The fit index included the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA). In this study, GFI, AGFI, and CFI values of greater than 0.9 and a RMSEA value of less than 0.08 indicate an acceptable fit.[14]

## RESULTS

Descriptive statistics were calculated for each scale in the study, prior to analysis. The number of items, mean scores, Cronbach's alpha, and correlations between the measures of the study variables are listed in **Table I**. As shown in Table I, ANE measures were significantly correlated with risk perception and incident involvement. Pilots with higher levels of ANEs were less accurate in their perception of risk during in-flight situations, and these pilots were more likely to be involved in incidents. Risk perception was also positively correlated with incident involvement. Pilots who perceived the risk in different scenarios to be high were less likely to be involved in incidents. In addition, proactive coping was correlated with ANEs and incident involvement. Pilots with more proactive coping skills had fewer ANEs and tended to be involved in far fewer incidents.

A structural equation model analysis was performed to examine whether the hypothesized effect of ANEs on incident involvement was mediated through risk perception. **Fig. 2** shows the tested model with standardized path coefficients. The fit measures showed that the proposed model has good fit with the data: $\chi^2 = 312.07$, df = 143, GFI = 0.90, AGFI = 0.87, CFI = 0.93, Non-Normed Fit Index (NNFI) = 0.92, RMSEA = 0.063. As shown in the path model, the effect of ANEs on incident involvement is significant ($B = 0.12$, $t = 2.07$, $P < 0.05$), which indicates that pilots with more ANEs tend to increase the possibility of involvement in incidents. Therefore, H1 is fully supported. Also, the path from ANEs to risk perception is significant ($B = -0.62$, $t = -9.74$, $P < 0.001$). This indicates that pilots with more ANEs tend to perceive the risk in situations as low. Therefore, H2 is fully supported. In addition, the effect of risk perception on incident involvement is significant and negative ($B = -0.49$, $t = -4.12$, $P < 0.001$). This supports our finding that a low level of risk perception increases the possibility of pilot involvement in incidents. This finding is in line with previous studies and supports H3.

The standard errors and 95% confidence intervals for these effects are generated by bootstrapping in AMOS. The indirect effect of ANEs on incident involvement mediated by risk perception is estimated to be $B = 0.30$ [95% CI = (0.082, 0.456)]. The 95% CIs do not include zero, which indicates that risk perception has a significant indirect effect. Also, the direct effect of ANEs on incident involvement is estimated to be $B = 0.12$ [95% CI = (0.09, 0.45)], and the 95% CIs do not include zero. Thus, the effect of ANEs on incident involvement is partially mediated by risk perception. Therefore, H4 is fully supported. The total effect of ANEs on incident involvement is estimated to be $B = 0.42$ [95% CI = (0.28, 0.55)]; the 95% CIs do not include zero, thus indicating that ANEs can significantly predict pilot involvement in incidents.

In this study, a regression analysis is used to test the moderating effect of proactive coping on the relationship between ANEs and incident involvement. The results of this analysis are displayed in **Table II**. After controlling for age and total flight time, the overall explanation rate of incident involvement significantly increased in the regression equation. Our results show that ANEs significantly predict pilot involvement in incidents ($B = 0.15$, $t = 2.73$, $P < 0.01$). The interaction between ANEs and proactive coping significantly predict pilot involvement in incidents ($B = -0.16$, $t = -2.98$, $P < 0.01$), which in turn indicates that a

**Table I.** Number of Items, Mean Scores, Cronbach's Alpha, and Correlations Among Measures of the Study Variables ($N = 295$).

| VARIABLES | MEAN | SD | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|
| Age | 31.43 | 6.73 | — | | | | | |
| Total flight time | 13,800 | 9547.03 | 0.92*** | — | | | | |
| ANEs | 2.61† | 6.59 | −0.16** | −0.20*** | **0.94** | | | |
| Risk perception | 60.3†† | 105.54 | −0.08 | 0.01 | −0.55*** | **0.88** | | |
| Proactive coping | 4.68‡ | 7.13 | 0.31*** | 0.31*** | −0.39*** | 0.02 | **0.84** | |
| Incident involvement | 3.46‡‡ | 2.10 | 0.17** | 0.03 | 0.28*** | −0.30*** | −0.32*** | **0.68** |

†Range 1-7; ††Range 1-100; ‡Range 1-6; ‡‡Range 0-5. Bold figures on the diagonal are alpha reliabilities of scales.
** $P < 0.01$; *** $P < 0.001$.

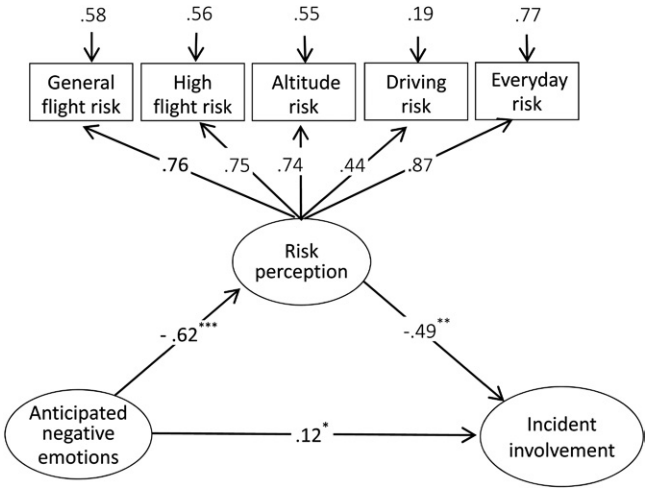


**Fig. 2.** Path diagram of the relationship between ANEs, risk perception, and incident involvement. *$P < 0.05$, **$P < 0.01$, and ***$P < 0.001$, respectively.

pilot's proactive coping skills can moderate the relationship between ANEs and the pilot's involvement in incidents. Consequently, H5 is strongly supported.

To understand proactive coping as a moderator of the results and to examine proactive coping's influence, we further examined the simple slope tendency. The scores of ANEs and proactive coping were divided into two groups: high scoring (Mean + 1 SD) and low scoring (Mean – 1 SD). The interaction of ANEs and proactive coping with incident involvement is presented in **Fig. 3**. As is shown in Fig. 3, pilot involvement in incidents decreased as their proactive coping skills increased in both the low and high-scoring groups of ANEs. In addition, the effect of ANEs in predicting incident involvement emerged as positive ($B = 0.35$, $t = 4.22$, $P = 0.000$) for pilots with high proactive coping skills, but negative and nonsignificant ($B = -0.02$, $t = -0.05$, $P = 0.96$) for pilots with low proactive coping skills. In other words, proactive coping weakened the relationship between civil pilots' ANEs and incident involvement. These findings indicate that proactive coping is more effective in helping pilots with high levels of ANEs to reduce the likelihood of being involved in incidents.

**Table II.** Results of Linear Hierarchical Regressions Analysis Regarding the Relationships Between ANEs, Proactive Coping, and Incident Involvement.

| | MODEL 1 | | MODEL 2 | | MODEL 3 | |
|---|---|---|---|---|---|---|
| **VARIABLES** | ***B*** | ***t*** | ***B*** | ***t*** | ***B*** | ***t*** |
| Step 1: Controlled variables | | | | | | |
| Age | 0.84*** | 6.10 | 0.87*** | 6.91 | 0.84*** | 6.70 |
| Total flight time | −0.73*** | −5.34 | −0.63*** | −4.96 | −0.57*** | −4.57 |
| Step 2: Predictor variables | | | | | | |
| ANEs | | | 0.15** | 2.77 | 0.15** | 2.73 |
| Proactive coping | | | −0.34*** | −6.02 | −0.36*** | −6.40 |
| Step 3: Interaction effect | | | | | | |
| ANEs × proactive coping | | | | | −0.16** | −2.98 |
| *F* | 18.79*** | | 27.47*** | | 24.35*** | |
| $R^2$ | 0.11 | | 0.28 | | 0.30 | |
| Adjust $R^2$ | 0.11 | | 0.27 | | 0.28 | |
| $\Delta R^2$ | 0.11 | | 0.16 | | 0.02 | |

All parameter coefficients are standardized estimates.
** $P < 0.01$; ***$P < 0.001$.

## DISCUSSION

The primary purpose of this study was to explore the relationships between ANEs, risk perception, proactive coping, and incident involvement among Chinese civil pilots. The results show that ANEs have a significantly positive effect on pilot involvement in incidents. Also, ANEs have an indirect effect on incident involvement through pilot risk perception. In addition, proactive coping was found to directly affect incident involvement and to moderate the former positive effect. Consequently, all five hypotheses put forward in this study are supported. These results have advanced the possibility that ANEs have broad implications in the field of aviation safety.

Many studies that look at uncertain situations have focused on to what degree emotional factors can predict pilot safety performance. The emotional factors include stress, anxiety, and degree of alertness, and a few studies have even included pilot ANEs. In this study, even after controlling for age and total flight time, ANEs still have a significant, positive, and direct predictive effect on pilot involvement in incidents. Pilots with lower levels of ANEs are found to be involved in fewer incidents, compared to their counterparts who reported higher levels of ANEs. The findings pertaining to ANEs are in line with expectations, based on the findings that ANEs can incite certain behaviors as a means to reduce the negative feelings caused by stressful settings.[2,15,31] Similar observations have also been made in the field of aviation.[3,5] A plausible explanation for these results is that people seek pleasure and avoid pain in their lives. These are basic human motivations.[16,34] An individual's decisions and behaviors are influenced by the pursuit of happiness or the avoidance of unhappiness. Therefore, in order to avoid the negative emotions caused by not landing on time at destination airports, pilots will actually take more risks than would normally be the case to ensure that flights land on time, despite adverse flight conditions. This behavior, caused directly by a desire to avoid negative emotions, causes more incident involvement.

In this study, ANEs show an indirect effect on pilot incident involvement via risk perception. Specifically, ANEs are exogenous variables that influence risk perception, which, in turn, influences incident involvement. Our study points to the negative association between ANEs and risk perception. Pilots with higher levels of ANEs are more likely to ignore the risks in an in-flight environment and thereby display a greater likelihood of incident involvement. A tentative explanation for this finding would be that ANEs caused by the potential stress of future events affect pilots' attentional control.[1] This results in pilots being unable

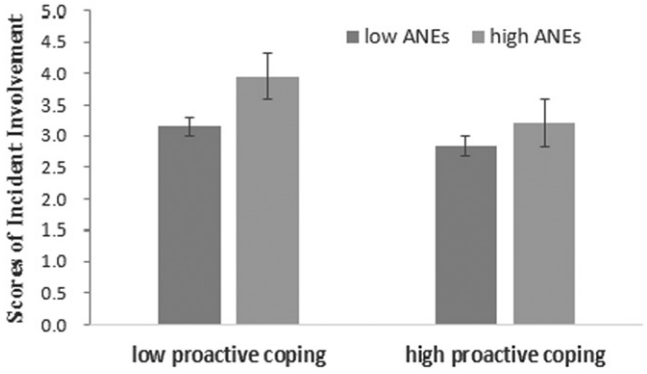


**Fig. 3.** The interaction effect of proactive coping and ANEs to incident involvement. The error bars represent the SEM.

to accurately acquire and evaluate the relevant cues from their external environment. For example, airline pilots are anxious to land at the destination airport on time (despite unfavorable weather conditions) so they can avoid anticipated negative emotions. This puts enormous pressure and a significant psychological burden on pilots. However, two attentional subsystems exist in the human brain: a goal-directed system and a stimulus-driven system.[7] The attentional control theory proposes that the negative emotions caused by stress can disrupt the balance between these two subsystems.[10] In this case, the stimulus-driven system will take precedence over the goal-directed system. This, in turn, will increase the randomness of pilot scanning behavior and make it more difficult for pilots to acquire effective information from their external environments.[1]

Furthermore, pilots with high levels of risk perception are found to have been involved in fewer incidents, compared to their counterparts who reported lower levels of risk perception. Thus, our results are consistent with the work of Hunter[19] and Ji et al.[23] A possible reason for these findings is that inaccurate risk perception may cause pilots to ignore or misunderstand external cues that require immediate and effective decision making to avoid hazards.[17] This lack of perception could result in a failure to update an individual's situational awareness model,[24] thereby increasing the likelihood of the pilot being involved in incidents. In other words, pilots with low levels of ANEs tended to perceive risks related to aviation accidents as high, and these pilots showed a lesser tendency to become involved in incidents. In summary, in our research, ANEs are found to have a significant total effect (direct effect and indirect effect by risk perception) on civil pilot involvement in incidents. Thus, there is reason to believe that ANEs could act as an effective predictor of civil pilot involvement in incidents.

Our research found that proactive coping has a moderating effect on the relationship between ANEs and incident involvement. Proactive coping weakens the relationship between ANEs and the level of incident involvement experienced by civil pilots. The results provide evidence that proactive coping is more effective in helping pilots who have high levels of ANEs to reduce the likelihood of being involved in incidents. A tentative explanation for this finding would be that individuals with high levels of ANEs show a far more excessive degree of concern regarding the behavioral outcomes of future events than do individuals with low levels of ANEs. However, the strategy of proactive coping accumulates certain resources and creates favorable conditions for dealing with hazardous events.[11] On the other hand, proactive coping also strengthens the cognitive connection between "future events (situation) and negative emotions" for pilots with high levels of ANEs. These ANEs would naturally bloom into immediate, strong, negative emotions when pilots actually encounter similar events or situations,[34] and this could adversely affect flight safety.

This paper finds that ANEs have a significant positive effect on pilot involvement in incidents. Therefore, one managerial implication of this paper's current findings is to acknowledge the importance of ANEs in aviation safety campaigns. From a practical perspective, psychological selection and training may provide a reliable way to reduce the possibility of incidents. Candidates with lower levels of ANEs may be chosen as flying cadets on the basis of a psychological selection test. With this selection method, the overall level of ANEs could be decreased in flying cadets, which is a good working basis for reducing pilot incident involvement. Moreover, airlines that emphasize productivity (e.g., on-time arrivals or saving fuel) may unconsciously be setting up conflicts between productivity goals and safety. This practice could increase the negative emotions experienced by pilots if they fail to arrive on time.[5] Thus, airlines should highlight the concept of "safety over productivity" in pilot training programs to reduce the ANEs that may result from organizational pressure. These steps could arguably decrease the levels of pilot incident involvement.

Risk perception exerts a partial mediating effect on the relationship between ANEs and pilot incident involvement. Accordingly, a potential meaningful intervention would be to pay greater attention to civil pilots' risk perception. This implies that additional training and automation design may be needed to help pilots improve their perception of flight risks. Training can influence and address how pilots recognize the cues related to high-risk situations, how pilots collect information from their environments, and how they assess their own personal capabilities.[23,35] The program "Weatherwise" provides pilots with the skills necessary to recognize and respond to the many cues associated with deteriorating weather conditions during flights.[33] These skills could reduce the possibility of pilots flying into adverse weather due to a lack of the ability to accurately perceive weather risks. Also, improving the standard of cockpit automation design could enable pilots to obtain more information. That would help pilots identify risks and upgrade their own levels of risk perception. Cockpit upgrades could include the design of improved warning equipment and weather radar systems.

Our results highlight the fact that proactive coping is more effective in helping pilots with high levels of ANEs to reduce the likelihood of being involved in incidents. Therefore, the promoting effect of proactive coping can only be fully realized when proactive coping training is designed to match the level of a pilot's ANEs. In particular, for pilots with high levels of ANEs,

we may focus on improving the level of proactive coping by training these pilots to compensate for the negative impact of ANEs on incident involvement. For instance, pilots should try to look at issues from alternative viewpoints in order to reduce the level of ANEs caused by risk events. These alternative viewpoints could include a positive evaluation of negative emotions and cognitive reconstruction (meaning discovery, humor, and weakening evaluation).

Despite the encouraging findings of this study, several limitations are noteworthy when interpreting the results of this current research and when contemplating future research. First, this study only examines the anticipated negative emotions caused when pilots fail to land the aircraft at the destination airport on time. Specifically, we only look at ANEs during the landing phase. Even though this is a typical and representative flight scenario, there is still a certain one-sidedness to the approach. Therefore, future studies could investigate the effects of anticipated negative emotions on pilot safety behaviors and involvement in incidents during other flight scenarios or phases. Such scenarios could include the phases of taking off and cruising. Secondly, we use a cross-sectional design in the current study, which restricts the predictive value of the study data. As a consequence, further research may employ a longitudinal design, in order to determine whether or not ANEs can predict civil pilots' involvement in incidents over time.

In conclusion, ANEs have both a direct and indirect effect (via risk perception) on pilot incident involvement. Also, the direct effect is moderated by proactive coping. Based on these findings, future aviation safety campaigns should make greater efforts to adopt a candidate selection process that incorporates the psychological aspect of testing for ANEs. Further efforts should be made to change pilots' risk perception (as associated with hazardous events) and to implement a program of training pilots in proactive coping competencies. Such measures would reduce the levels of civil pilot incident involvement. In particular, such training may be more effective in helping pilots with high levels of ANEs to reduce the likelihood of becoming involved in incidents.

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Hongwei Wang and Quan Xu are co-first authors.

*Authors and affiliations:* Hongwei Wang, Ph.D. candidate, and Xiong You, Ph.D., School of Geospatial Information, People's Liberation Army of China (PLA) Information Engineering University, Zhengzhou, Honan Province, China; Hongwei Wang, Ph.D. candidate, Flight Safety Research Institution, People's Liberation Army of China (PLA) Aviation University of the Air Force, and Quan Xu, Ph.D. candidate, Can Yang, Master, and Ming Ji, Ph.D., Shaanxi Provincial Key Laboratory of Behavior and Cognitive Neuroscience, Xi'an, Shaanxi, China; and Quan Xu, Ph.D. candidate, Can Yang, Master, and Ming Ji, Ph.D., School of Psychology, Shaanxi Normal University, Xi'an, Shaanxi, China.

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