EMBRY-RIDDLE Aeronautical University SCHOLARLY COMMONS

Journal of Aviation/Aerospace Education & Research

Volume 29
Number 2 *JAAER 2020*

Article 3

2020

# Aviation Education Impacts on Cockpit Culture of Chinese Student Pilots

Xiaoyu Wu
*Griffith University, Australia*, xiaoyu.wu@slu.edu

Yujia Liu
*Civil Aviation Flight University of China*, liuyujia1988@qq.com

Terrence Kelly
*Saint Louis University*, terrence.kelly@slu.edu

## Introduction

In high-consequence industries, culture ties to safety performance (Eurocontrol, 2008; Ford, Henderson, & O'Hare, 2014; Griffin & Neal, 2000; Patankar & Sabin, 2010; Wiegmann, Zhang, Von Thaden, Sharma, & Gibbons, 2004). Creating a safe culture in the workplace is intrinsic to safety performance.

Studying culture, Hofstede (1979) developed a framework that can help people in measuring a culture. He identified several culture variables and suggested that national culture could be identified using these variables: Power Distance, Individualism/Collectivism, Long Term Orientation, Masculinity/Femininity, Indulgence, and Uncertainty Avoidance (Hofstede, 1979, 1980; Hofstede, Hofstede, & Minkov, 1991; Minkov & Hofstede, 2012a). Hofstede further developed an index system to describe these cultural variables that have been found helpful in defining the national culture.

Many studies have shown the effectiveness of creating a safe environment in accident prevention using Hofstede's national culture model (Hallowell, 2010; Helmreich, 1999; International Civil Aviation Organization [ICAO], 2013; Wiegmann et al., 2004). In aviation, Helmreich (1984) suggested that pilots' behaviors can be determined by one or more of these culture variables. For example, pilots with a high perception of Power Distance may be more likely to follow orders and adhere to the Standard Operating Procedures (SOP). Pilots from countries with strong individualism orientation may try to be more independent, more flexible, and use company procedures with more discretion (Helmreich, 1984).

However, people create cultures, and cultures are dynamic (Harari, 2014). The dynamic nature of culture allows for interventions and positive changes (Sussman, 2000). A four-year aviation academic program is an educational intervention designed to increase ideal safety-

oriented cultural competence in professional pilots; thus, it should bring some changes to the culture of students. This study proposes to study several characteristics that have been attributed to national culture and assess whether a well-established aviation education system can influence the national culture traits among Chinese students. Do Chinese student pilots have different index profiles of cockpit culture variables regarding their academic tenure? In order to answer this question, one hypothesis has been developed:

*Hypothesis 1a. The profiles of cockpit culture variables between first-year students, sophomores, juniors, and seniors are the same.*

## Review of the Literature

### Aviation Safety and Culture

Safety is a primary concern for the aviation industry. Spangenberg et al. (2003) found that national culture differences were the reason why Danish workers had approximately four times the lost-time injury rate of Swedish workers. This phenomenon was observed during a joint-venture to construct the 16 km road/rail link across Øresund. Casey, Riseborough, and Krauss (2015) found that the national culture of a country impacts its perceptions of safety. In the study, Casey et al. (2015) observed that even following the same company training and guidance, the safety performance of employees was diverse, based on the difference of the various national cultural background. Noort, Reader, Shorrock, and Kirwan (2016) argues that National cultural tendencies for Uncertainty Avoidance are negatively associated with safety culture.

The National Transportation Safety Board (NTSB) (2000) suggested that a relatively flat Power Distance in the cockpit is desired. Merriti and Helmreich (1996) argued that beneficial cockpit safety performance is based upon a strong Collectivism. Ely and Meyerson (2006)

indicated that a work environment that is less Masculinity would have a better workplace safety record. Therefore, the ideal cockpit culture in the aviation contains a low perception of Power Distance, Masculinity, Individualism, and a high perception of Uncertainty Avoidance.

**Hofstede's Culture Dimensions**

In Hofstede's framework, Power Distance, Individualism, Masculinity, and Uncertainty Avoidance can be measured by survey tools, and Merritt (2000) created an instrument suitable for the aviation field to access these national culture variables. Hofstede provides an index system to describe national culture variables. Within this research, national culture survey items were used to calculate index scores from the variables on national value systems that are components of national cultures. All survey items were scored on a five-point scale. Index scores were derived from the mean scores of the questions for samples of respondents (Minkov & Hofstede, 2012b) by using the following equation. The following equation in which μ is the mean score for each question, ω is the weight for each question.

$$Index = \frac{\sum_{i=1}^{n} \omega_i \cdot \mu_i}{n} \times 100$$

The index score has a value of between 0 and 100 typically, but values below 0 and above 100 are technically possible. In Power Distance, an index value of 0 means a low perception in a hierarchy, and an index value of 100 means a high perception in a hierarchy. In Individualism / Collectivism, an index value of 0 equates to a weak individualism and a strong collectivism score, and an index value of 100 denotes strong individualism and weak collectivism. In Masculinity / Femininity, an index value of 0 means less masculinity and more femininity, and an index value of 100 means more masculinity. In Uncertainty Avoidance, an index value of 0 means weak uncertainty avoidance, and an index value of 100 means strong uncertainty avoidance (Hofstede, 1980; Merritt, 2000).

## Profile Analysis

Profile analysis is a subset application of Multivariate Analysis of Variance (MANOVA), which can compare profiles of two or more groups measured on the same dependent variables repeatedly. The profile analysis can answer significant questions as to whether groups have different profiles based on a set of measures (Tabachnick, Fidell, & Osterlind, 2001). The profile analysis can build a profile addressing certain dependent variables for each group, and it can provide information, such as parallelism of profiles, overall difference, and flatness of profiles.

For a MANOVA, all dependent variables must be subjected to the same scaling techniques. The profile analysis also requires a multivariate normal distribution to generate a credible result. It will be open to interpretations to evaluate the credibility of a dataset that is small, unequal, or has dependent normality. As a result, sample groups should have equal size. Also, the equal sample size of groups can avoid the evaluation of homogeneity of variance-covariance matrices (Tabachnick et al., 2001).

Three tests are commonly used in profile analysis: a test of equal levels, a test of flatness, and a test of parallelism. Each test aims to articulate specific research questions. The profile analysis may also visualize the profile of each group.

## Survey

The study used the Cockpit Culture Survey authored by Merritt (2000) to measure aspects of Power Distance, Individualism / Collectivism, Masculinity / Femininity, and Uncertainty Avoidance among Chinese student pilots. Merritt (2000) showed that the correlation between cockpit culture and Hofstede's dimensions was significant with a correlation coefficient of 0.96 in Individualism, a correlation coefficient of 0.87 in Power Distance, a correlation

coefficient of 0.75 in Masculinity, and a correlation coefficient of 0.68 in Uncertainty Avoidance. The significant correlations show that the Hofstede's culture dimensions can be found in the cockpit environment.

**Sample**

The participants were recruited from two Chinese universities with a flight program. The students received the survey in the student chatting groups on WeChat. WeChat is a widely used Chinese social media.

Seven hundred ninety-two Chinese student pilots responded to the cockpit culture survey. After cleaning some missing data, 792 cases were analyzed for the study. The size sample was approximately 15% of all Chinese registered student pilots. Chinese student pilot participants were divided into four groups based on their tenure in the school. Two hundred thirty-eight freshman year student pilots participated in the study, 166 sophomore year student pilots, 171 junior year student pilots, and 217 senior year student pilots. Table 1 shows the number of participants based on their tenure.

Table 1

*Chinese Training Schools' Participants Information on School Years*

| Academic Tenure | Number |
|---|---|
| First-year students | 238 |
| Sophomores | 166 |
| Junior | 171 |
| Senior | 217 |
| Total | 792 |

**Principle Component Analysis**

The sample size of 792 in this study is adequate to conduct PCA according to Tabachnick and Fidell (2007). The Kaiser-Meyer-Oklin measure of sampling adequacy (KMO) of this study was 0.85, which indicates the sampling is adequate (Tabachnick & Fidell, 2007). Bartlett's Test

of Sphericity (Bartlett's test) was conducted. The results for Bartlett's test was $\chi 2(n = 919) = 4975.077$, and p-value 0.001. Results of Bartlett's test suggested sufficiently large correlations between items to use PCA. Table 2 shows the PCA result.

Table 2

*PCA – Initial Eigenvalue & Cumulative Variables*

| Factor | Initial Eigenvalue | Cumulative Variables |
|---|---|---|
| 1 | 4.79 | 23.97% |
| 2 | 2.85 | 38.19% |
| 3 | 1.31 | 44.38% |
| 4 | 1.21 | 50.19% |

Based on the suggestion of Stevens (2012), factors with loadings above 0.4 were extracted and identified. The survey item was discarded if the loading did not reach 0.4. Negative loading scores indicated a negative relationship between the abstracted factor and the survey item. The factor loadings and questions are presented in the appendix.

## Result

The research question set a scope on academic year level moderation of the change in Individualism, Uncertainty Avoidance, Power Distance, and Masculinity. The researcher conducted a profile analysis to test the hypothesis that was associated with the research question. The profile provides three types of information for any group: mean score, deviations, and the overall shape.

To answer the research question, the Hypothesis H1a suggests that the profiles of first-year students, sophomores, juniors, and seniors are the same regarding the dependent cockpit culture variables. The profile analysis was conducted to test the null hypotheses; the profile analysis contained three tests: a test of parallel, a test of equal level, and a test of flat.

The null hypothesis of the test of parallel was that among different levels of education of Chinese students, the individual differences between the mean values of the scores are equal. Table 3 shows the results.

Table 3

*Profile Analysis Hypotheses Test of Parallel*

| Statistic | Value | F-Value | p-value |
|---|---|---|---|
| Wilks | 0.95 | 3.77 | 0.000 |
| Pillai | 0.05 | 3.73 | 0.000 |
| Hotelling-Lawley | 0.05 | 3.79 | 0.000 |
| Roy | 0.04 | 9.75 | 0.000 |

Under the test of parallel, the null hypothesis was rejected. The profile of each group of students was not parallel with each other. Among different Chinese students' academic tenures, there were the respective differences between the mean values of the scores. The data cannot pass the test of parallel, so there is no need to conduct the future test of the profile. The researcher rejects the Hypotheses 1a. The Figure 1 shows the profile of perception of Individualism, Uncertainty Avoidance, Power Distance, and Masculinity for four academic year Chinese student pilots.

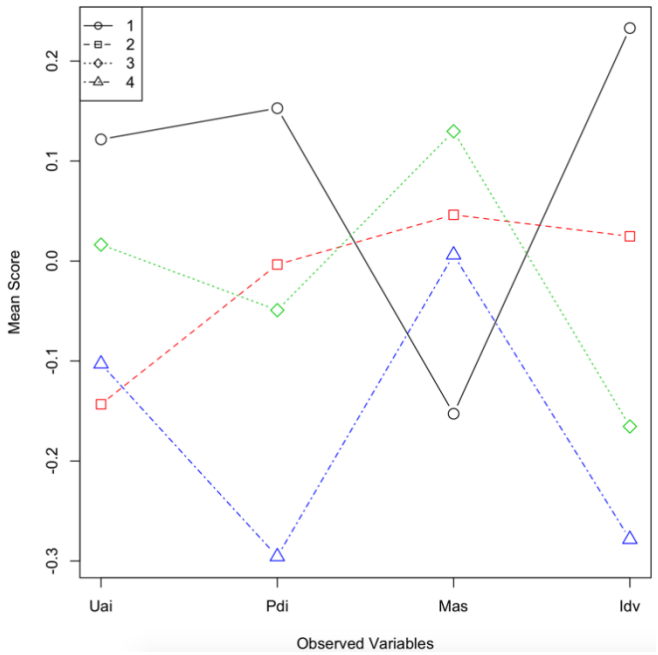


*Figure 1.* Profile of perception of Individualism, Uncertainty Avoidance, Power Distance, and Masculinity for four academic year Chinese student pilots.

## Discussion

This question only conducted a profile analysis among students who received flight training in China. These student pilots were determined to have different index profiles regarding cockpit culture variables (see Figure 1). The freshmen and sophomores had unique profiles, and juniors and seniors had similar profiles. However, the seniors' profiles had much lower index scores on cockpit culture variables than ones of juniors.

Overall profiles comparison: it was reasoned that juniors and seniors might share a similar profile due to the exposure to actual flight training. In China, student pilots begin flight training in their junior year. The actual cockpit experience may profoundly impact the forming of national culture. Figure 1 showed that during the junior year, student pilots started to form a national culture that the aviation industry would prefer. Cockpit culture profile for juniors becomes very different from first-year students and sophomores.

Within juniors and seniors, the increasing hours of flight and aviation education improved student pilots' perception of Power Distance, Individualism, Masculinity, and Uncertainty Avoidance furthermore. In the senior year, student pilots have an index score of cockpit culture variables that have been perceived as ideal by the aviation industry ideally. The exception was the Uncertainty Avoidance.

In the perception of Power Distance, the four-year pilot program reduced the index score dramatically. Considering that Chinese society had a strong appearance of hierarchy, the positive effect of a well-established four-year pilot program on the perception of Power Distance became significant. Assuming the freshmen had the society baseline of the perception of Power Distance, through the pilot program, students received an education about Power Distance and the importance of a low hierarchy atmosphere in the cockpit. During their studying period, textbooks, lectures, flying practices, and accident examples demonstrated that good communication and cooperation in the cockpit relied on a low Power Distance environment — the reduced index score correlated with students' academic tenures. Thus, senior year students had the lowest index score of Power Distance within all Chinese trained student pilots in this survey.

The four-year pilot program reduced Chinese student pilots' perception of Individualism. The pattern of profiles on the index score of Individualism was the same as previously discussed Power Distance. With the progression of the program, the index score of Individualism decreased. First-year students had the highest score of the Individualism index, and seniors had the lowest score of the Individualism index. The finding raison d'être may be that all participants had a contract with commercial airlines, which the Chinese pilot program was designed to train a Chinese commercial pilot. Crew Resource Management (CRM) course, or

other likewise team resource management courses, was introduced to students in their first year and second year of study. When students started flying, they practiced CRM from day one (Civil Aviation Administration of China [CAAC], 2011). This professional, pilot-oriented program further reduces the perception of Individualism in a low Individualism country.

Regarding the perception of Masculinity (Ely & Meyerson, 2006)[1], the freshmen had the lowest index score value of Masculinity; the juniors had the highest index score value of Masculinity; the seniors and sophomores were falling in between, and the sophomores had a higher index score than seniors. In this study, the survey was not designed to measure Masculinity narrowly but measure the willingness to accept an individual's mistakes, errors, and vulnerableness.

One reason for this finding may be due to college experiences. The first year of college is usually stressful, intimidating, and depressing (Dyson & Renk, 2006). First-year students usually feel less Masculinity and much more willing to admit mistakes and errors (Capraro, 2000). With students' growing college living experiences and adaption to the college environment, the perception of Masculinity increased and peaked in the junior years (Bem, 1974). This situation may be strengthened by the population of the study group, which was overwhelming male.

The finding of Uncertainty Avoidance was similar to the finding of Masculinity. The freshmen had the highest index score value of Uncertainty Avoidance, and sophomores had the lowest index score value; the juniors and seniors were falling in between, and the juniors had a higher index score than seniors. The reason behind this phenomenon may still reside in the

[1] Here the narrow term means the common perception of masculinity. According to previous research, masculinity refers to denying errors and mistakes. Therefore, we put it over here to indicate masculinity means these factors. More can be found at https://hbswk.hbs.edu/item/manly-men-oil-platforms-and-breaking-stereotypes

experiences of school life and the general social norm regarding rules. First, China has a low Uncertainty Avoidance perception; it is not a rule-oriented country. Second, the decrease of the perception of Uncertainty Avoidance was periodical; sophomores and seniors who were in the second year of their training stage had lower index scores. First-year students and sophomores had no flight experiences. When students first come to the school, they were not familiar with the operation on the campus. A rule-oriented opinion would dominate the students' attitude. When they adapted the environment, the perception of Uncertainty Avoidance decreased. Juniors and seniors had flight experiences, and the flight training started in junior year. Juniors encountered this new flying operation environment, and students went through the same adapting process again. Therefore, changes in perception of Uncertainty Avoidance were found to be periodical.

## Limitations

First, there is a significant limitation to the further development of the sampling, primarily concerning the expense and time required. This research is not longitudinal research that focuses on the same group of people. Instead, this study drew samples from each year of the pilot program with an assumption that the start point of the cockpit culture was the same.

Second, this study has limited generalizability. This study focuses on how initial flight training experiences impact the formation of cockpit culture among Chinese student pilots. Thus, the study does not reflect the cockpit culture of commercial airline pilots, nor how continuing educational training —such as Crew Resource Management (CRM) training and refresher training —impact the nature of cockpit culture. The survey data was self-reported in this study. The students were inexperienced pilots who may not know how they may react in the

illustrative scenarios that the survey is asking them to evaluate. Their responses may be hypothetical.

Third, this study did not eliminate individual personality differences. The questions that had been posed to the participants were generic and did not reflect an individual's ability to perceive the culture. The study was built upon an assumption that the sample size in each group was large enough to aggregate individual personalities.

Lastly, this study is limited to a quantitative analysis of cockpit culture in Chinese student pilots. As such, the depth and breadth of the meanings and interpretations of the study may be limited.

## Recommendations for Future Work

The scope of this work was limited to self-reporting data and academic tenure. Influential elements to a cockpit culture contain more elements than this study has investigated. Further research should examine the impact of additional elements on forming cockpit culture.

First, this study demonstrated that the profile of the cockpit culture changes dramatically between students with flight experiences and without flight experiences. The certification would depict a clear picture of the level of flight experiences and cockpit culture.

Second, obtaining the data from instructors and commercial airline pilots can make the understanding of cockpit culture development much deeper. Instructors directly interact with student pilots; their perception of cockpit culture may impact students the most. With data from commercial airline pilots, it is possible to picture the leap of cockpit culture from a student to professional pilots.

Last but not the least, an accurate longitudinal study should be conducted. A close following of one group of students and measuring their cockpit culture perception during their studying time can make the study more robust.

## References

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology*, *42*(2), 155-162. https://doi.org/10.1037/h0036215

Capraro, R. L. (2000). Why college men drink: Alcohol, adventure, and the paradox of masculinity. *Journal of American College Health*, *48*(6), 307–315. https://doi.org/10.1080/07448480009596272

Casey, T. W., Riseborough, K. M., & Krauss, A. D. (2015). Do you see what I see? Effects of national culture on employees' safety-related perceptions and behavior. *Accident Analysis & Prevention*, *78*, 173–184. https://doi.org/10.1016/j.aap.2015.03.010

Civil Aviation Administration of China (CAAC). (2011, January). The requirement of flight training on high performance aircraft. Retrieved from http://www.caac.gov.cn/XXGK/XXGK/GFXWJ/201511/P020151103347308442804.pdf

Dyson, R., & Renk, K. (2006). Freshmen adaptation to university life: Depressive symptoms, stress, and coping. *Journal of Clinical Psychology*, *62*(10), 1231–1244. https://doi.org/10.1002/jclp.20295

Ely, R. J., & Meyerson, D. E. (2006, August). Unmasking manly men: The organizational reconstruction of men's identity. In *Academy of Management Proceedings* (Vol. 2006, No. 1, pp. J1-J6). Briarcliff Manor, NY: Academy of Management. https://doi.org/10.5465/ambpp.2006.27161322

Eurocontrol. (2008, December). *Eurocontrol/FAA Action Plan 15 Safety - Safety culture in air traffic management: A white paper.* Government report. Retrieved from https://www.skybrary.aero/bookshelf/books/564.pdf

Ford, J., Henderson, R., & O'Hare, D. (2014). The effects of crew resource management (CRM) training on flight attendants' safety attitudes. *Journal of Safety Research, 48,* 49–56. https://doi.org/10.1016/j.jsr.2013.11.003

Griffin, M. A., & Neal, A. (2000). Perceptions of safety at work: A framework for linking safety climate to safety performance, knowledge, and motivation. *Journal of Occupational Health Psychology, 5*(3), 347. https://doi.org/10.1037/1076-8998.5.3.347

Hallowell, M. (2010). Safety risk perception in construction companies in the Pacific Northwest of the USA. *Construction Management and Economics, 28*(4), 403–413. https://doi.org/10.1080/01446191003587752

Harari, Y. N. (2014). *Sapiens: A brief history of humankind*. London, England: Harvill Secker.

Helmreich, R. L. (1984). Cockpit management attitudes. *Human Factors: The Journal of the Human Factors and Ergonomics Society, 26*(5), 583–589. https://doi.org/10.1177/001872088402600510

Helmreich, R. L. (1999). Building safety on the three cultures of aviation. In *Proceedings of the IATA Human Factors seminar* (pp. 39–43). Bangkok, Thailand, August 12, 1998.

Hofstede, G. (1979). Value systems in forty countries: Interpretation, validation and consequences for theory, cross cultural contributions to psychology. In L. H. Eckensberger, W. J. Lonner, & Y. H. Poortinga (Eds.), *Cross-Cultural contributions to psychology.* Lisse, Netherlands: Swets and Zeitlinger.

Hofstede, G. (1980). *Cultures consequences.* Beverly Hills, CA: Sage.

Hofstede, G., Hofstede, G. J., & Minkov, M. (1991). *Cultures and organizations: Software of the mind* (Vol. 2). Citeseer.

International Civil Aviation Organization (ICAO). (2013). *Document 9859 safety management manual.*

National Transportation Safety Board (NTSB). (2000). Controlled flight into terrain, Korean Air flight 801, Boeing 747-300, HL7468, Nimitz Hill, Guam, August 6, 1997. Online.

Noort, M. C., Reader, T. W., Shorrock, S., & Kirwan, B. (2016). The relationship between national culture and safety culture: Implications for international safety culture assessments. *Journal of Occupational and Organizational Psychology, 89*(3), 515-538. https://doi.org/10.1111/joop.12139

Merriti, A. C., & Helmreich, R. L. (1996). Human factors on the flight deck: The influence of national culture. *Journal of Cross-Cultural Psychology, 27*(1), 5–24. https://doi.org/10.1177/0022022196271001

Merritt, A. (2000). Culture in the cockpit: Do Hofstede's dimensions replicate? *Journal of Cross-Cultural Psychology, 31*(3), 283–301. https://doi.org/10.1177/0022022100031003001

Minkov, M., & Hofstede, G. (2012a). *Cross-cultural analysis: The science and art of comparing the world's modern societies and their cultures.* Thousand Oaks, CA: Sage. https://doi.org/10.4135/9781483384719

Minkov, M., & Hofstede, G. (2012b). Hofstede's fifth dimension: New evidence from the world values survey. *Journal of Cross-Cultural Psychology, 43*(1), 3–14. https://doi.org/10.1177/0022022110388567

Patankar, M. S., & Sabin, E. J. (2010). The safety culture perspective. *Human Factors in Aviation,* 95-122.

Spangenberg, S., Baarts, C., Dyreborg, J., Jensen, L., Kines, P., & Mikkelsen, K. L. (2003). Factors contributing to the differences in work related injury rates between Danish and Swedish construction workers. *Safety Science, 41*(6), 517–530. https://doi.org/10.1016/S0925-7535(02)00007-3

Stevens, J. P. (2012). *Applied multivariate statistics for the social sciences*. New York, NY: Routledge.

Sussman, N. M. (2000). The dynamic nature of cultural identity throughout cultural transitions: Why home is not so sweet. *Personality and Social Psychology Review, 4*(4), 355–373. https://doi.org/10.1207/S15327957PSPR0404_5

Tabachnick, B. G., & Fidell, L. S. (2007). *Experimental designs using Anova*. Thomson/Brooks/Cole.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. J. (2001). *Using multivariate statistics*. Boston, MA: Allyn and Bacon.

Wiegmann, D. A., Zhang, H., von Thaden, T. L., Sharma, G., & Gibbons, A. M. (2004). Safety culture: An integrative review. *The International Journal of Aviation Psychology*, *14*(2), 117–134. https://doi.org/10.1207/s15327108ijap1402_1

# Appendix

Table A.1 Survey Questions for Accessing Chinese Student Pilots' National Culture and PCA result.

| | Factor | | | |
|---|---|---|---|---|
| Questions | 1 | 2 | 3 | 4 |
| A Captain should encourage crew member questions -R | 0.74 | | | |
| It is important to find the truth, the correct answer, the one solution | -0.71 | | | |
| It is important to me that I respect the decisions made by my group-R | 0.70 | | | |
| If I perceive a problem, I will speak up -R | 0.68 | | | |
| I preferred to work for a consultative leader -R | 0.59 | | | |
| Organization's rules should not be broken | -0.56 | | | |
| How often are you afraid to disagree with your instructors | | 0.77 | | |
| How often do you feel nervous or tense during a flight | | 0.75 | | |
| In abnormal situations, I rely on superiors to tell me what to do | | 0.68 | | |
| I need sufficient time for personal and family life | | 0.63 | | |
| A Self-reporting system is useless. Nobody would use it. -R | | -0.62 | | |
| A First Officer should never assume command of the aircraft | | 0.51 | | |
| I get a personal sense of satisfaction from challenging tasks | | | 0.69 | |
| I like changing my work routine with new unfamiliar tasks -R | | | -0.58 | |
| Competition is the law of nature | | | 0.55 | |
| My personal problems can adversely affect my performance | | | | 0.79 |
| I prefer to work alone | | | | 0.52 |
| Written procedures are required for all in-flight situation | | | | 0.49 |
| My decision-making ability is as good in emergencies as in it is daily routine tasks | | | | 0.41 |

Note: The questions with "R" in the table means that the item is measured in reverse scoring. The survey is adapted from National culture survey (Merritt, 2000).