

# Psychophysiological coherence training reduces pilots' perceived stress in flight operations

Laurie Marsman<sup>1,2</sup>, Jingyi Zhang<sup>1</sup> & Wen-Chin Li<sup>1</sup>

<sup>1</sup>Safety and Human Factors in Aviation, SATM, Cranfield University, UK, <sup>2</sup>Netherlands Aerospace Centre (NLR)

---

## SUMMARY

The present paper reports the results of a four-week study assessing the relationship between psychophysiological coherence training, which aims to improve the synchronisation between one's physiological rhythms leading to a positive emotional state, and perceived stress levels in commercial air transport pilots. Next to three self-report stress questionnaire measurements, qualitative data were gathered as well to gain more insights into the training effects. Results show significant reductions in the flight crew's perceived stress levels during the four-week psychophysiological coherence practice period. Finally, the results are discussed.

## KEYWORDS

Heart Rate Variability, Resilience, Aviation, Safety, Human Factors

---

## Introduction

Fatigue and stress are well-documented issues within the field of aviation, with far-reaching consequences for all personnel, including pilots. Effective strategies are needed to mitigate the risk these adverse physiological and psychological states pose for aviation safety. One potential solution is fostering pilots' psychophysiological coherence, which is defined as a positive emotional state in which physiological rhythms between the heart and brain become synchronised (Field, 2018), leading to a sense of mental clarity. Such a state is characterised by a low-frequency heart-rate variability (HRV) of around 0.1 Hz (McCraty, 2022). One technique to achieve higher coherence levels is the Quick Coherence Technique (QCT), which instructs participants to breathe at a calm, comfortable pace while accessing positive feelings and focusing attention on the heart (Henriques et al., 2011).

It is possible to visualise one's HRV through biofeedback methods, which depict bodily functions to gain more awareness of one's body. Eventually, the goal is to achieve a state of coherence without biofeedback, ensuing better cognitive performance, and fewer negative emotional states like stress. Currently, psychophysiological coherence training is not used for flight crew. However, there are ample indications that this group can significantly benefit from such training, as flight crews tend to suffer from adverse mental states which can impact their performance and thus flight safety. Hence, this paper investigates the impact of coherence training on flight crew's perceived stress.

## Methods

Participants include staff of an international airline (N=28) based at a London airport, all of which signed up voluntarily. No inclusion or exclusion criteria were used. Nine participants (32.14%) are captains, seventeen (60.17%) are first-officers and two (7.14%) are Human Factors experts within

the airline. Ethical approval was provided by the Cranfield University Research Ethics System (CURES/16348/2022) and all participants provided their informed consent.

Each participant took part in a one-day training course in which principles of psychophysiological coherence were explained and participants were introduced to the non-intrusive HeartMath Inner Balance biofeedback device used during the study. During the training day, stress levels were assessed with the Perceived Stress Scale (PSS) as a pre-measurement. The PSS is a highly validated scale in a variety of samples (Lee, 2012), and contains ten items which are answered on a scale of 0 (Never) to 4 (Very often). Thus, the total PSS score lies between 0-40, with higher scores indicating higher stress levels. After the training day, participants completed four weeks of independent coherence practice using QCT. Using a within-subjects design, stress levels were assessed in the middle of training and at the end of training, resulting in three PSS measurements. Participants were encouraged to practice the QCT as often as possible with a recommended six sessions a day, three of which are baseline measurements, the other three QCT practice sessions.

## Results

Firstly, it was verified that QCT practice ( $M = 3.715$ ) resulted in significantly higher coherence scores than baseline measurements ( $M = 1.506$ ) over the four-week period, using a repeated-measures ANOVA ( $F(1, 21) = 102.792, p < .001, \eta^2 = .830$ ). Seven participants (25%) did not complete all PSS-measurements; hence they are removed from analysis. For the remaining 21 participants, a repeated measures ANOVA was conducted with the PSS scores as dependent variable and time (pre, during, post) as within-subject factor, showing a strong significant main effect of time ( $F(2, 18) = 33.996, p < .001, \eta^2 = .791$ ). Univariate follow-up shows strong significant main effects of time on the during versus pre-measurement ( $F(1, 19) = 26.638, p < .001, \eta^2 = .584$ ) and on the post versus pre-measurement ( $F(1, 19) = 65.071, p < .001, \eta^2 = .774$ ). The pre, during, and post-measurement EM means are 19.850, 13.550, and 13.400 respectively.

## Discussion

The present results show significant reductions in flight crew's perceived stress levels during the four-week period of coherence practice, indicating that coherence training is indeed effective in lowering perceived stress levels in commercial air transport pilots, which may positively affect their performance on the flight deck. It should be noted, however, that neither participants' coherence progress, nor the number of completed practice sessions are considered in this paper. Moreover, participants registered for the study voluntarily, highlighting a potential self-selection bias which could have influenced the results.

Regardless, participants provided detailed qualitative feedback after practice sessions, in which they report "I'm feeling slightly calmer after QCT sessions" and "I am beginning to see a marked improvement to my stress levels and situations I would normally find stressful, I'm able to manage more thoughtfully", suggesting that coherence practice may make a marked difference in participants' experienced stress levels.

Importantly, more research is needed to establish a more definite link between coherence training and flight crew's stress levels and subsequent performance, preferably including control groups, and more detailed stress, coherence progress, and in-flight performance assessments. The social importance of such research cannot be understated: The impact of pilots' adverse mental states on pilot performance and flight safety is well documented, hence effective interventions to further mitigate this problem are needed.

## References

- Field L. H. L., Edwards, S. D., Edwards, D. J., & Dean, S. E. (2018). Influence of HeartMath training programme on physiological and psychological variables. *Global Journal of Health Science*, 10(2), 126. <https://doi.org/10.5539/gjhs.v10n2p126>
- Henriques, G., Keffer, S., Abrahamson, C., & Jeanne Horst, S. (2011). Exploring the effectiveness of a computer-based heart rate variability biofeedback program in reducing anxiety in college students. *Applied Psychophysiology and Biofeedback*, 36(2), 101-112. <https://doi.org/10.1007/s10484-011-9151-4>
- Lee, E. (2012). Review of the psychometric evidence of the perceived stress scale. *Asian Nursing Research*, 6(4), 121-127. <https://doi.org/10.1016/j.anr.2012.08.004>
- McCarty, R. (2022). Following the rhythm of the heart: HeartMath institute's path to HRV biofeedback. *Applied Psychophysiology and Biofeedback*. <https://doi.org/10.1007/s10484-022-09554-2>