

Feasibility study of ability assessment using fNIRS

Measuring Brain Function in the Aircraft Sector

Data provided by: All Nippon Airways Co., Ltd. (ANA)

Key Points

- (1) Differences in dorsolateral prefrontal cortex (DLPFC) activity between expert captains and young trainees were assessed using fNIRS during two aircraft landing simulations differing in degree of difficulty, utilizing a flight simulator used in actual flight training.
- (2) Expert captains showed significantly higher DLPFC activity in the left hemisphere than in the right one, whereas no significant (n.s.) difference was observed in the young trainees.
- (3) The result suggests that training as an airline pilot for over 20 years influences brain activity, and it may be possible for fNIRS to assist in assessing such abilities.

Regions of Measurement

- Number of subjects: 12 male pilots employed by ANA
6 expert captains: 48 ± 4 years of age; total flying time: 10,490 ± 1,260 hours
6 young trainees: 24 ± 2 years of age; total flying time: 120 ± 72 hours
- Measurement positions: 22 channels in the prefrontal area (We set the ROI of DLPFC, calculating the Brodmann area contribution distribution, using the Fastrak 3D digitizer and NIRS-SPM software.) (Fig. 1a)



Fig. 1 a. Regions of Interest: Left/Right DLPFC b. Testing Conditions Using the ANA Blue Base Boeing 767-300 Twin Engine Simulator

Task & Analysis

Pilots were asked to fly at 2000 ft using a flight simulator, after relaxing for 2 min. The protocol consisted of 5 landings: 2 easy tasks and 3 difficult tasks (Fig. 2). The data were preprocessed with a low-pass filter and a cutoff frequency of 0.1 Hz and extracted the functional component using a hemodynamic modality separation method algorithm. Baseline correction was performed to set the task starting point of each data to zero. After these processes, the average value of the Oxy-Hb concentration changes in the flight from 1500 ft to 500 ft was computed.

In the same segment, the deviations from the ideal value of each flight simulator parameter (airspeed, pitch, and so on) were integrated to score. The lower the score, the better the performance.

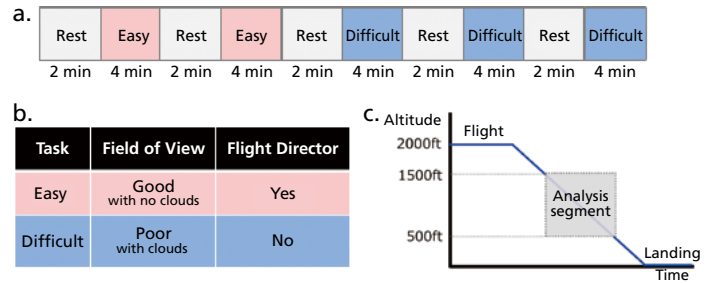


Fig. 2 a. Measurement Protocol Overview b. Details of Easy Tasks and Difficult Tasks c. Data Segments Used in the Analysis

Data

Expert captains performed better on the flight simulator than young trainees, regardless of the difficulty of the task. DLPFC activity tended to be higher in the difficult task than in the easy task in both groups of subjects. The expert captains had higher DLPFC activity levels than the young trainees irrespective of the level of difficulty. The expert captains conducted the flight in consideration of unforeseen circumstances. This may be the cause of the high DLPFC activity. In the overall result of easy and difficult tasks (average of 5 landings), expert captains showed significantly higher left DLPFC activity than the right one ($p < 0.001$), whereas there was no significant difference in the young trainees (Fig. 3). It has been reported that the brain activity of the elderly is more characteristic than that of the young, and there is a cognitive aging model that states: "Brain activity during cognitive performances tends to be less lateralized in the elderly than in the young, because the left and right sides of the brain cooperate to compensate for the functional decline." These results suggest trainees who are younger but not performing well use their left and right brains to perform tasks, while expert captains, who are older but performing well, use their left DLPFC to perform tasks. This provides evidence that the lateralization in the model is not based on age but on differences in ability and proficiency, suggesting that fNIRS may be a useful tool for assessing ability.

Reference

1) K Kawaguchi, et al.(2024).Heliyon. 2024 Apr 25;10(9):e30242. doi: 10.1016/j.heliyon.2024.e30242. eCollection 2024 May 15.

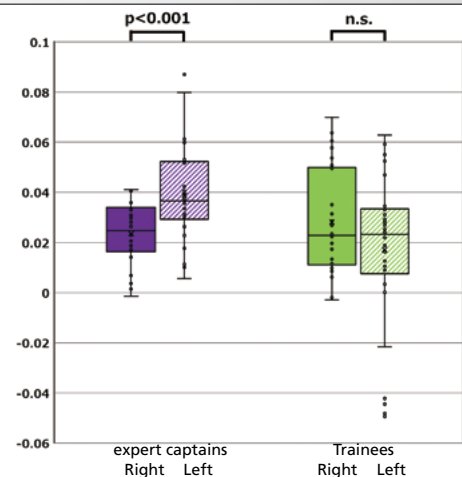




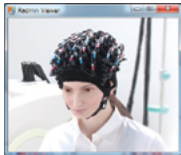


Fig. 3 Comparison of Left/Right Differences in DLPFC Activity between Expert Captains and Young Trainees

System configuration



This data was obtained with the following compact and affordable portable system.

Product	Overview
LIGHTNIRS™ • One LIGHTNIRS main unit (22 channels)	 
Holder, type A 2 m optical fibers for LIGHTNIRS (8 sets)	 
3D position measurement system Video system	   

Suitable for a wide range of research applications

There is also a highly expandable system, which can perform measurements seamlessly across a wider range.

This instrument is applicable for a wide range of research applications.

Product	Overview
LABNIRS™ main unit, 8 sets (24 channels, type L optical fibers) • Reference Minimum 4 sets, 10 channels Maximum 40 sets, 142 channels	
Complete head holder	

Cerebral function imaging (fNIRS) >

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