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SUMMARY

Boeing forecast that globally an additional 602,000 pilots will be needed by 2041 to meet year on year growth of 3.6% in passenger traffic. All pilots need to be trained in accordance with accepted regulatory standards. New technology is continuously being developed to enhance training and reduce training time. Research into the effectiveness of training technologies and how these impact pilot performance and workload is key to future growth. One such technology under review at the University of Birmingham is the 'audible intelligent assistant'. This artificial voice that provides real-time feedback to the pilot during flight training. The system provides warnings, cautions and instruction to the human pilot to enhance pilot training. Preliminary results of the research showed an improvement in pilot performance against a specified set of target parameters of airspeed and altitude and a corresponding decrease in workload for 80% of pilots when using the audible intelligent assistant. Without AIA, pilot performance improved by 35% due to learning effects alone, with AIA pilot performance showed an improvement of 65%.

KEYWORDS

Pilot Training, Audible Intelligent Assistant, Performance, Workload

The Experiment

A range of experiments were conducted to determine the effects on Pilot Performance and Workload using the audible intelligent assistant (AIA). Ten participants with real-time flying experience between 5 and 50 hours and were randomly selected from University of Birmingham students. All participant's data were deidentified and aggregated and followed the University's ethical procedures. The mean number of hours flying being 9 and mean age of the participants was 20 across the cohort of 10 participants. The participants were split allocated to two groups. Group 1 - the control group - who performed flight exercises without the audible assistant, and Group 2 - the experimental group – who performed exercises with the AIA. During the experiments, the AIA (based on gaming technology) was combined with a basic fixed-base flight simulator to provide audible instructions, cautions and warnings to the pilot based on their performance of the flying task in the circuit. The amount of verbal communications was standardised however more erratic flying would result in more instruction, cautions and warnings. Indicated performance parameters were used to determine the pilot's variation from the target and to analyse the pilot's performance within a set completion standard set out by the FAA in accordance with the suitable aircraft parameters for the Cessna C172. A NASA-TLX survey was used post-flight to assess Pilot Workload for the given flying tasks.

Analysis

The preliminary results of this study indicated that pilots in the experimental group demonstrated greater performance increases while using the AIA, with 26 out of 40 parameters (65%) across the 5 pilots. Four out of five of the pilots in the experimental group showed a reduction in workload compared to the control group. With respect to the measured performance parameters of altitude,

airspeed and heading during the final approach, the experimental group showed significant improvements between the first and second circuits. However, both experimental and control groups struggled to show a clear improvement in performance in the crosswind, downwind and base leg of the flight. There were marginal improvements in performance between the two groups of pilots for the take-off (heading and bank angles) with the use of the AIA. The control group (not using the aid) showed a decrease in performance for 24 out of 40 parameters (60%) across the all 5 pilots and an increase in workload for 4 out of 5 of the group. The parameters recorded being airspeed, altitude, and average bank angle as well as 5 different headings for each turn of the circuit. The preliminary results suggest that use of such an audible tool can simultaneously improve performance and decrease workload leading to safer and more cost effective pilot training. The perceived increase in workload and recorded decrease in performance for the control group between circuits may have been due to self-reflection and self-induced pressure to demonstrate improvement, without feedback. The AIA provided clear instruction prior to flight about the aircraft's capabilities for a turn but also, warnings during flight. For example, the yaw effects that an single engine propeller driven aircraft encounters due to the application of full power for the take-off run may be countered by prompts from the intelligent audible assistant. However, this instruction usually came too late during the take-off run and yawing was evident hence no clear improvement. The audible assistant was constantly providing instructions based on airspeed and altitude benefitting the pilot's performance and showing a clear improvement and stability of the engine power. The reason for both groups showing significant improvement on the final approach heading was due to pilots relying upon their cognitive skills and using the information provided in the briefing to point out a visual landmark that could be used as a turning point (to compensate for the limited horizontal field of view in the simulator). A lack of improvement in heading between the two groups is partly due to the lack of communication from the assistant, potentially also due to the coarse divisions of the compass heading system used (5 deg.), thus the required headings lie between these values and made reading subjective. Furthermore, the tone at which this audible instruction is provided can have a significant effect on performance, with pilots benefitting more positively in terms of performance from negative or neutral tones. The audible software gave no positive reassurance or praise for a pilot's accomplishments in any scenarios and tended only to highlight mistakes or the need for improvements. Also considered are how the software displays the four key aspects of feedback (Molesworth et al., 2006; Molesworth et al., 2011) such as when, how often and what feedback is provided as well as how much consideration is needed to execute the feedback.

Impact & implications

While the results of the research highlight the potential benefits for training, all the pilots had different simulator experiences which may have affected results slightly. Despite reasonable fidelity of the simulator, 100% replication of real flying experience was not possible. The results may have been influenced by the pilot's individual learning preferences either visual or auditory learners (Chui et al, 2020). During basic student pilot training typically, a flight instructor would provide audible instructions and crucial training points however the information provided is sometimes inconsistent within the flight school environment. Using an audible assistant in training could improve standardisation and suggests that pilot performance can be improved, and pilot workload simultaneously reduced for the limited parameter set analysed. These changes could have a beneficial impact on student pilot training leading to greater efficiency and safety. When not using AIA, performance decreased, and workload increased. Further experiments are planned with increased participants, but initial signs are encouraging and use of an AIA may be a first step towards improving the quality and consistency of flight training whilst also reducing cost.

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