Student-instructor workload in simulated and real flight

Author

Evy van Weelden – Department of Cognitive Science and Artificial Intelligence, T ilburg University, Tilburg, the Netherlands

Maryam Alimardani – Department of Computer Science, V rije Universiteit, Amsterdam, the Netherlands

Travis J. Wiltshire – Department of Cognitive Science and Artificial Intelligence, T ilburg University, Tilburg, the Netherlands

Raphaelle N. Roy – Federation ENAC ISAE – SUPAERO ONERA, Universite de Toulouse, France

Frederic Dehais – Federation ENAC ISAE – SUPAERO ONERA, Universite de Toulouse, France

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1 Synopsis

In the context of flight training, monitoring the mental workload of both students and instructors is important for a holistic view of overall training progress and evaluation. This study explored the subjective workload experienced by student pilots and their instructors during simulated and real flight, and how it was affected by their type of cooperation: 1) pilot monitoring (PM), in which the student was the co-pilot, observing and assisting the instructor, and 2) pilot flying (PF), in which the student was flying the aircraft and the instructor served as the co-pilot. Eight student pilots and two instructors participated in our study. The results showed that real flight induced higher subjective workload for student pilots and instructors than simulated flight, as did PF compared to PM.

2 Background

The assessment of workload remains crucial for understanding a novice pilot's capabilities and progressions during flight training, for real and simulated flight scenarios alike [1, 2, 3]. Instructors utilize workload assessment to tailor instructions and tasks to individual students' needs [2]. However, as instructor workload increases, the accuracy of their subjective evaluation of their student's performance can diminish [4]. Notably, a student's training progress and success are profoundly influenced by their instructor, surpassing the impact of the simulator type or training syllabus [5]. This underscores the necessity of monitoring both instructors' and students' workload.

Past research shows that adopting various roles during training (e.g., PF and PM) can impact the perceived workload and alter the interaction dynamics within the dyad [6, 7]. However, how one's role during flight training in different environments affects various aspects of mental workload for the dyad is unknown. This study examined how performing different roles during training in simulated and real flight influences perception of workload for both the instructor and the student pilot. We gathered subjective and electrophysiological measures to assess various aspects of mental workload [4, 8, 9]. This paper presents subjective measures to investigate how training environment and role affect perceived mental workload.

3 Methods

3.1 Participants

Eight male student pilots (M_{age} = 27.88, SD_{age} = 11.38) with varying levels of flight experience (flight hours range: [9, 13300], M = 1720.50, SD = 4679.72) and two instructors (flight hours range: [112, 6500]) associated with ISAE-SUPAERO, Toulouse, France, voluntarily joined this experiment. All student pilots formed dyads in the simulator with one of the instructors (instructor 1), and in real flight with the other instructor (instructor 2).

3.2 Procedure

All student pilots participated in two experimental sessions, once in the simulator and once in real flight. In both sessions, they took turns to perform four consecutive standard flight traffic patterns (with touch-and-go in-between consecutive flight patterns), either as the main pilot (PF, pilot flying) or co-pilot (PM, pilot monitoring). The order of the conditions was randomized and pre-determined for each experiment.

3.3 Materials

Real flight experiments took place in a P-68 vulcanair aircraft (Toulouse Lasbordes airfield, France), while the simulator experiments took place in the ISAE-SUPAERO fixed-wing simulator.

After experiments, (raw and shortened) NASA-TLX [10] were acquired for each of the four flight traffic patterns from the students and instructors to assess subjective workload. The following scales were included: mental demand, temporal demand, situational stress, and task complexity.

Here, we report the means and standard deviations (*SD* s) of the NASA-TLX scores. We do not report statistical tests, due to the small sample size and lack of statistical power.

4 Results

Figure 1 and Figure 2 present the means and *SD* s obtained from this small sample. The results highlight potential differences in perceived workload between the two environments (i.e., real flight and simulator), and conditions (i.e., PF and PM), with real flight and PF condition eliciting higher reports of subjective workload for the student pilots on average.

The instructors scored generally lower on subjective measures of workload. Again, the real flight seemed to indicate higher perception of workload. The PF condition, in which the learners were actively controlling the (simulated or real) aircraft and the instructors were observing and tutoring, also resulted in more workload for the instructors compared to the PM condition.

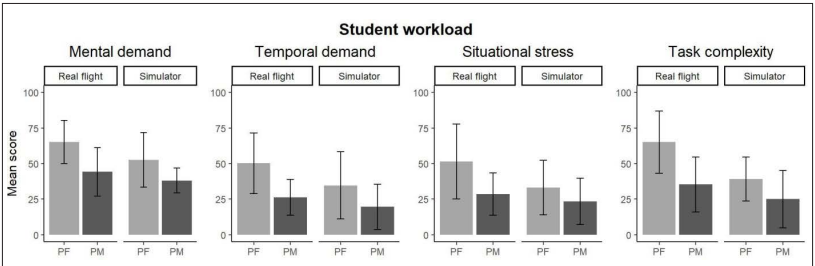

FIGURE 1
Subjective measures of student workload reported for four scales of the NASA-TLX.

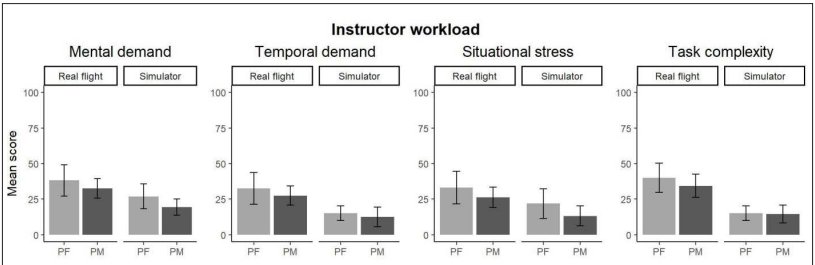

FIGURE 2
Subjective measures of instructor workload reported for four scales of the NASA-TLX.

5 Discussion

In this study, we explored subjective measures of workload obtained after both simulated and real flight scenarios. Our observations revealed that the subjective workload reported by instructors was consistently

lower than that reported by student pilots. This observation aligns with the notion that mental workload can vary based on individual experience levels [11]. As anticipated, our study corroborates the idea that flying under actual flight conditions elicits higher mental workload compared to simulated environments [12],[13]. Furthermore, we found that student pilots

experienced a higher workload across both training environments when they took the role of primary pilot (PF condition), with real flight being the most demanding setting. This finding is consistent with prior research, such as that of [14], which demonstrated differences in NASA- TLX scores between PM and PF conditions, using an adapted version of the NASA Multi-Attribute Task Battery (MATB).

Future research will concentrate on analyzing both subjective and electrophysiological data to bolster our findings related to workload. Additionally, it will examine the physiological synchrony [15] between student pilots and flight instructors to uncover the dynamics of collaboration and its impact on students' workload.

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