Pilot Perception and Confidence of Location During a Simulated Helicopter Navigation Task

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Yang JH, Cowden BT, Kennedy Q, Schramm H, Sullivan J. *Pilot perception and confidence of location during a simulated helicopter navigation task.* **Aviat Space Environ Med 2013; 84:952–60.**

Introduction: This paper aims to provide insights into human perception, navigation performance, and confidence in helicopter overland navigation. Helicopter overland navigation is a challenging mission area because it is a complex cognitive task, and failing to recognize when the aircraft is off-course can lead to operational failures and mishaps. ***Methods:*** A human-in-the-loop experiment to investigate pilot perception during simulated overland navigation by analyzing actual navigation trajectory, pilots' perceived location, and corresponding confidence levels was designed. There were 15 military officers with prior overland navigation experience who completed 4 simulated low-level navigation routes, 2 of which entailed auto-navigation. This route was paused roughly every 30 s for the subject to mark their perceived location on the map and their confidence level using a customized program. ***Results:*** Analysis shows that there is no correlation between perceived and actual location of the aircraft, nor between confidence level and actual location. There is, however, some evidence that there is a correlation ($\rho = -0.60 \sim -0.65$) between perceived location and intended route of flight, suggesting that there is a bias toward believing one is on the intended flight route. ***Discussion:*** If aviation personnel can proactively identify the circumstances in which usual misperceptions occur in navigation, they may reduce mission failure and accident rate. Fleet squadrons and instructional commands can benefit from this study to improve operations that require low-level flight while also improving crew resource management.

Keywords: navigation, perception, confidence, bias, terrain association.

OVERLAND VISUAL navigation at low altitudes, which we define as flight at or below 200 ft (~61 m) above ground level (AGL) is an increasingly important task for rotary wing aviators. Surprisingly, the factors that determine success in low level navigation are not well understood. Our research seeks to further the study of aviation by quantitatively studying pilot performance in a controlled experimental environment.

Airborne navigation—the act of understanding where the aircraft is and which direction it should travel next—is important both for mission accomplishment and hazard avoidance. If the aircraft is not where it is supposed to be, it cannot accomplish its mission. Hazard avoidance encompasses both point hazards, such as power lines, and area hazards, such as active ranges. Military settings include hazards of enemy action, which may be of either type. At higher altitude, navigation may be performed by various means including: dead reckoning, visual navigation, radio aids to navigation, global positioning system (GPS), and inertial navigation systems. GPS and inertial navigation systems are frequently combined, and are referred to as hybrid navigation or simply G/INS. A summary of several common methods follows; for details, see Eschenbach and Stanski-Pacis and de Voogt (6,10). Adam et al. (1) address issues arising around the usability and potential pitfalls with current cockpit GPS systems and Casner (2) discusses training requirements for GPS usage.

The low-level navigation environment is different from navigation at altitude for several reasons. Radio aids to navigation may be unreliable. This increases the relative importance of other methods, particularly visual navigation. Visual navigation also is of increased importance at low altitudes for hazard avoidance. Although training is a part of all navigation tasks, it is most critical for visual navigation. A look at the Naval Safety Center's statistics page (8) points to the importance and risk of helicopter overland navigation. For example, on 21 December 2011, an MH-60S struck trees and crashed in an open area during a day mountain flight.

Crew coordination at low altitudes requires division of duties between the flying pilot, who we will henceforth refer to as the 'pilot at the controls' (PAC) and the nonflying pilot, who we henceforth refer to as the 'pilot not at controls' (PNAC). The PAC is typically responsible for the tasks required to safely pilot the aircraft and for critical responses during emergencies. The PNAC is responsible for communication, planning, and navigation. Both pilots are responsible for the identification and avoidance of obstacles, as appropriate. We are reminded in the work of de Voogt et al. (5) that the notion of 'crew' frequently includes those who are not physically present in the aircraft, including other aircraft in a formation, controllers, and ground crews.

Broadly speaking, a pilot may be on-course or off-course, and he may perceive himself to be on-course or off-course. Sullivan (11) summarizes this, as does **Table I**.

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This manuscript was received for review in July 2012. It was accepted for publication in March 2013.

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DOI: 10.3357/ASEM.3505.2013