Vigilance impossible: Diligence, distraction, and daydreaming all lead to failures in a practical monitoring task

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A R T I C L E   I N F O

A B S T R A C T

In laboratory studies of vigilance, participants watch for unusual events in a "sit and stare" fashion as their performance typically declines over time. But watch keepers in practical settings seldom approach monitoring in such simplistic ways and controlled environments. We observed airline pilots performing routine monitoring duties in the cockpit. Unlike laboratory studies, pilots' monitoring did not deteriorate amidst prolonged vigils. Monitoring was frequently interrupted by other pop-up tasks and misses followed. However, when free from these distractions, pilots reported copious mind wandering. Pilots often confined their mind wandering to times in which their monitoring performance would not conspicuously suffer. But when no convenient times were available, pilots mind wandered anyway and misses ensued. Real-world monitors may be caught between a continuous vigilance approach that is doomed to fail, a dynamic environment that cannot be fully controlled, and what may be an irresistible urge to let one's thoughts drift.

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1. Introduction

In 1972, the crew of Eastern Air Lines Flight 401 became distracted when an indicator light designed to verify that the airplane's landing gear was down and locked failed to illuminate. As the crew worked together to resolve the problem, which in cruel irony turned out to be only a burned-out light bulb, the airplane continued a slow and unnoticed descent into the Florida Everglades (NTSB, 1973).

In response to this landmark accident, airlines redefined the roles of the two pilots in the cockpit. From then on, one pilot (called the *pilot flying*) would assume primary responsibility for operating the controls of the airplane, while the other pilot (the *pilot monitoring*) would serve as the "second set of eyes" in the cockpit, occasionally assisting the pilot flying in his or her duties but primarily performing the job of keeping watch for anything amiss. Moreover, airline companies devised explicit procedures to be used by monitoring pilots. Monitoring pilots were formally tasked with making verbal callouts as airplanes climbed or descended to or away from assigned altitudes in order to raise awareness among the crew about what the airplane was doing.

But despite these remedial steps, accidents related to lapses in monitoring continued to occur (NTSB, 1994). As recently as 2013, yet another crash occurred in San Francisco after the flight crew failed to notice that the airplane had slowed to an unsafe speed during approach (NTSB, 2014). An unsettling detail about the San Francisco accident was that, unlike most

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flights in which two pilots sit in the cockpit, this flight had four. None of the four pilots noticed the deteriorating airspeed that was shown on a simplistic cockpit instrument and positioned in plain view directly in front of them.

The persistence of airline crashes related to monitoring failures, despite the attention given to most every conceivable aspect of the problem, lead us to wonder if there is something fundamentally wrong with the very idea of placing a human in a supervisory role, however well-trained and experienced they may be. Do our troubles begin when we so much as *attempt* to watch over the shoulder of someone or something else while it works?

1.1. Why vigilance sometimes fails

Upon first glance, the problem of keeping watch for things gone amiss in an environment such as an airline cockpit seems simple enough. Unfortunately, countless studies have shown us that the process of paying attention while watching others work can go wrong in several ways.

1.1.1. Depletion

Thousands of laboratory experiments have demonstrated what happens when participants are asked to monitor a stimulus or process in a prolonged "sit and stare" fashion. What is invariably found is that a decline in performance eventually sets in (Mackworth, 1948; Teichner, 1972). Many argue that the cause of this vigilance decrement is the depletion of cognitive resources needed to perform what is an arduous, stressful, high-workload task (Dillard et al., 2015; Helton & Warm, 2008; Warm, Parasuraman, & Matthews, 2008). As participants work to maintain their focus on whatever they have been assigned to monitor, their stores of cognitive energy are depleted faster than they can be replenished.

1.1.2. External distractions

Early researchers such as Mackie (1987) were quick to point out that, in real-life monitoring tasks, outside the guarded door of the research laboratory, people seldom have the opportunity to sit and stare for extended periods of time. For example, monitoring pilots are periodically asked to answer radio calls from air traffic control or to read checklists. In separate studies of lifeguards and prison guards, Harrell (1999) and Tickner, Poulton, Copeman, and Simmons (1972) found that guards' scanning was also frequently interrupted by other duties such as responding to rule violations that they are tasked with monitoring.

The problem with these momentary distractions from the monitoring task is that they too can lead to monitoring misses. Studies of the deleterious effects of having to divide our attention between more than one task go beyond demonstrating that we are likely to miss something that lies to the left when our attention is momentarily diverted to the right. It has been demonstrated that we often "look but do not see" when cognitive resources needed to meaningfully process what we are monitoring are tied up by another task such as talking or listening (Strayer & Johnston, 2001). Einstein, McDaniel, Pagan, and Dismukes (2003) demonstrated that even momentary attentional diversions often lead to forgotten intentions associated with a monitoring task.

1.1.3. Internal distractions

Other researchers have shown us that, while people work, they sometimes turn their thoughts to matters that are unrelated to the task at hand, and that during these mental excursions, things can slip by unnoticed (Smallwood & Schooler, 2006).

Some researchers argue that mind wandering is the greater threat during a mundane vigilance task (Manly, Robertson, Galloway, & Hawkins, 1999). They argue that mind wandering gradually encroaches upon us, often without our awareness, when we perform monotonous or boring tasks over prolonged periods of time. Ariga and Lleras (2011) suggest that we may knowingly engage in mind wandering when we wish to take mental breaks from a tiring monitoring task. But Kurzban, Duckworth, Kable, and Myers (2013), and Thomson, Besner, and Smilek (2015) have yet a different take on mind wandering. These researchers suggest that we turn to mind wandering when we feel that our attentional resources might be more profitably directed elsewhere. After assessing the frequency at which events of interest might occur during a monitoring task, people may reallocate their limited attentional resources based on the likely reward for monitoring and the opportunity costs associated with not doing or thinking about something else. Casner and Schooler (2014) have already demonstrated that the successful use of highly reliable cockpit automation is associated with frequent reports of task-unrelated thoughts among airline pilots.

1.2. Is vigilance impossible?

These three reasons for which monitoring is suspected to fail, that have been so often studied independently in laboratory settings, combine to offer a rather bleak outlook for those who monitor in real-world settings. It seems that if we set out to actively monitor for long stretches of time, our performance predictably slumps. If we choose to (or are required to) perform other tasks that may arise, we get distracted and miss things for another reason. And if we allow our thoughts to drift onto other matters to take breaks, because we think our attention is not needed, because we find mind wandering irresistible, or simply because we think we can get away with it, we miss things for yet another reason. Whether we are diligent, distracted, or daydreaming, is monitoring doomed to fail?