Effects of cyclic loading on complex performance and operator functional state

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Abstract

Performance failures in complex work environments have widespread and profound consequences. Advances in the understanding of stress effects have been hindered by equivocal results and methodological and theoretical problems. Hockey's Compensatory Control Model (CCM) addresses these issues by emphasising the adaptive abilities of the responsible performer to protect important task goals, but at a cost of latent decrements on less salient tasks and compromised operator functional state. The present study tested CCM predictions under conditions of sustained task demand. Changing task load was manipulated using a cyclic loading method, with objective task demand increasing then decreasing over a 105 min session. Performance was assessed on a primary task and two embedded secondary tasks, using the Cabin Air Management System as an experimental test-bed. Sub-sessions and hysteresis measures were employed to assess fatigue accumulation and dissipation during performance, and allow the collection of self-report subjective ratings of effort, fatigue and anxiety. Primary task performance remained stable over changes in workload, with evidence of decrement only for secondary tasks. As predicted by CCM, effort was selectively increased towards the primary task under higher loads. Performance protection incurred fatigue costs, which failed to dissipate during the unloading phase. The present results offered broad support for CCM predictions of the pattern of breakdown under high demand.

Introduction

Though performance failures in complex work environments are uncommon, the costs associated with these rare events are high, as witnessed in large scale industrial and mass transportation accidents (e.g., Bhopal, Chernobyl, and Ladbroke Grove). Accordingly, efforts should be made to minimise the likelihood of accidents such as these taking place. Research examining the dynamic relationship between the human operators and their task environments plays a key role in this process. However, the safety-critical nature of operational work environments such as these all makes it impossible (or at least unlikely) to employ experimental manipulations of factors that may influence operator performance. Hence, any attempts to assess threat through empirical examinations must be conducted using analogue environments or laboratory-based simulations. One problem associated with this strategy is that laboratory examinations of load and stress effects on performance have historically

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