## Title
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**Journal**
Proceedings of the Annual Meeting of the Cognitive Science Society, 20(0)

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**Publication Date**
1998

Peer reviewed

# Modeling Dual-Task Performance Improvement with EPIC-Soar

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"What is the nature of the knowledge that defines the executive process and how can this knowledge be learned?" In Chong & Laird (1997), we took the first steps to address these questions for the Wickens' Task (the concurrent performance of a tracking task and a CRT task) using the EPIC-Soar hybrid architecture. We identified four classes of executive knowledge and posited possible sources for the knowledge for three of the four. The fourth class, called *strategic,* consisted of two instances: *anticipatory motor programming* and *pipelining*. At the time, we had no satisfactory hypothesis for the origin of the *strategic* knowledge class.

A key observation of these two instances is that they produce expert performance because they allow whole commands (or parts of command processing) to be moved, or *promoted*, to *chronologically earlier perceptual events*. This observation of motor promotions is the inspiration for a task-independent promotion-based learning procedure briefly presented here.

The learning procedure itself consists of three styles of promotions: *prepare promotions* (which create anticipatory motor programming rules), and *perceptual-event promotions* and *motor-status promotions* (which combine to produce pipelining rules). To support the learning procedure, a *chronological task strategy* data structure was invented to represent a subject's initial knowledge about the chronological ordering of perceptual task events and the associated motor commands (per the task instructions). This chronological task strategy data structure is essential to the procedure because it keeps track of the chronology of events as promotions are made and it also identifies which promotion styles can be performed. The learning procedure runs concurrently with task performance, so performance is improved while the task is being performed.

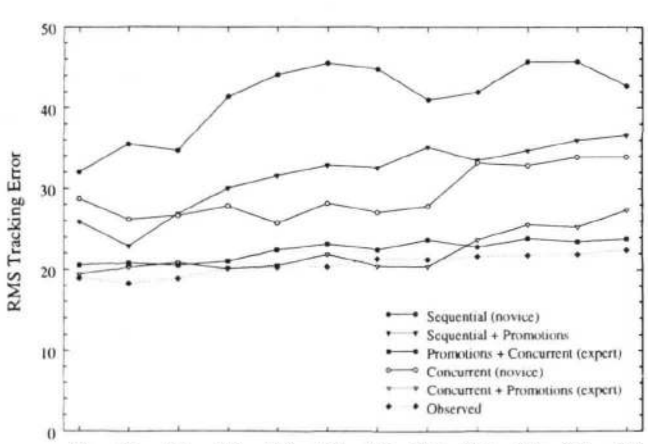


Figure 1: The evolution of tracking performance

The first three traces in the legend of Figure 1 show the performance evolution of an initially-sequential (IS) novice model that **began** with a *sequential dual-task strategy* (tracking halts when the CRT stimulus appears and resumes after the response is sent). The promotion learning procedure produced a large reduction in tracking error. Then with a minor change to one of the Soar rules to abandon the initial sequential strategy for a *concurrent dual-task strategy* (tracking is uninterrupted by CRT stimulus appearance), the final performance was a good match to the observed data.

In a second training run, we used an initially-concurrent (IC) novice model that **began** with the concurrent dual-task strategy. ("Concurrent (novice)" trace in Figure 1.) We expected that the promotion learning procedure would produce the same (or at least an equally good) final performance fit regardless of the dual-task strategy initially used by the novice model. However, as seen by the "Concurrent (expert)" trace in Figure 1, the model predicted that final performance is not the same under this condition.

This unexpected result however may be consistent with the general findings of a study by Gopher (1993) that examined the effects on final performance of varied task emphasis during dual-task training. Post-training performance was found to be superior for subjects who were made to vary task priorities during training (VP) compared to subjects who were either in the equal-priority (EP) or no-priority (NP) groups.

Gopher's VP training group can be viewed as analogous to the IS model since it initially emphasized the CRT task and then was later changed to equal emphasis. Similarly, the EP training group can be viewed as analogous to the IC model since it used equal emphasis throughout. The RMS error of the final performance of the IS and IC models relative to the observed data was 1.88 and 2.36 with a correlation of 0.89 and 0.74 respectively. In the same way that VP was better than EP, so IS was better than IC. Therefore, we tentatively take the prediction of the model to be correct.

## References

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