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EEG- and context-based cognitive-state classifications lead to improved team performance in a vehicle crew

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We present an augmented cognition (AugCog) system that utilizes two sources to assess cognitive state as a basis for actions to improve operator performance. First, continuous EEG is measured and signal processing algorithms utilized to identify patterns of activity indicative of high cognitive demand. Second, data from the automobile is used to infer the ongoing driving context.

22 subjects participated in the experiment in eleven 2-person crews consisting of a driver/ navigator and a commander/gunner. Participants drove a closed circle test route not exceeding 30 km/h. While driving, the driver received through headphones a series of communications and had to perform two secondary tasks. For one, he had to categorize communications by pushing one of five labeled buttons mounted on the dash. For the second, he had to push a separate dash-mounted button in response to communications containing the call sign assigned to the crew.

Certain segments of the route were designated as threat zones. The commander was alerted when entering a threat zone by a verbal warning in their headphones and by the sound of machine gun fire. Within a threat zone, their task was to detect targets mounted on the roadside and engage those targets using a gun mount on the roof of the vehicle (no gun affixed) To determine targeting success, a photo was taken with each activation of the trigger and these photos were assessed with respect to the position of the reticle relative to the target. In a secondary task, the commander was presented a series of communications through headphones and had to indicate communications that contained the crew's assigned call sign by pressing a button on the control handle mounted on the armrest.

Performance measures included: accuracy and reaction time in categorizing communications (driver only), accuracy of shots on targets and time to successfully engage targets (commander only), as well as accuracy and RT in detecting call signs (both crew members).

Our results show that it is possible to reliably discriminate different cognitive states on the basis of neuronal signals. The results also confirmed our hypothesis: there was no performance degradation in the driver's primary task, as well as no performance degradation in the commander's primary task, and there was performance improvement at the crew level in the AugCog condition for the shared, mitigated call sign task as compared to the reference session (unmitigated condition) and the design-driven mitigation.

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