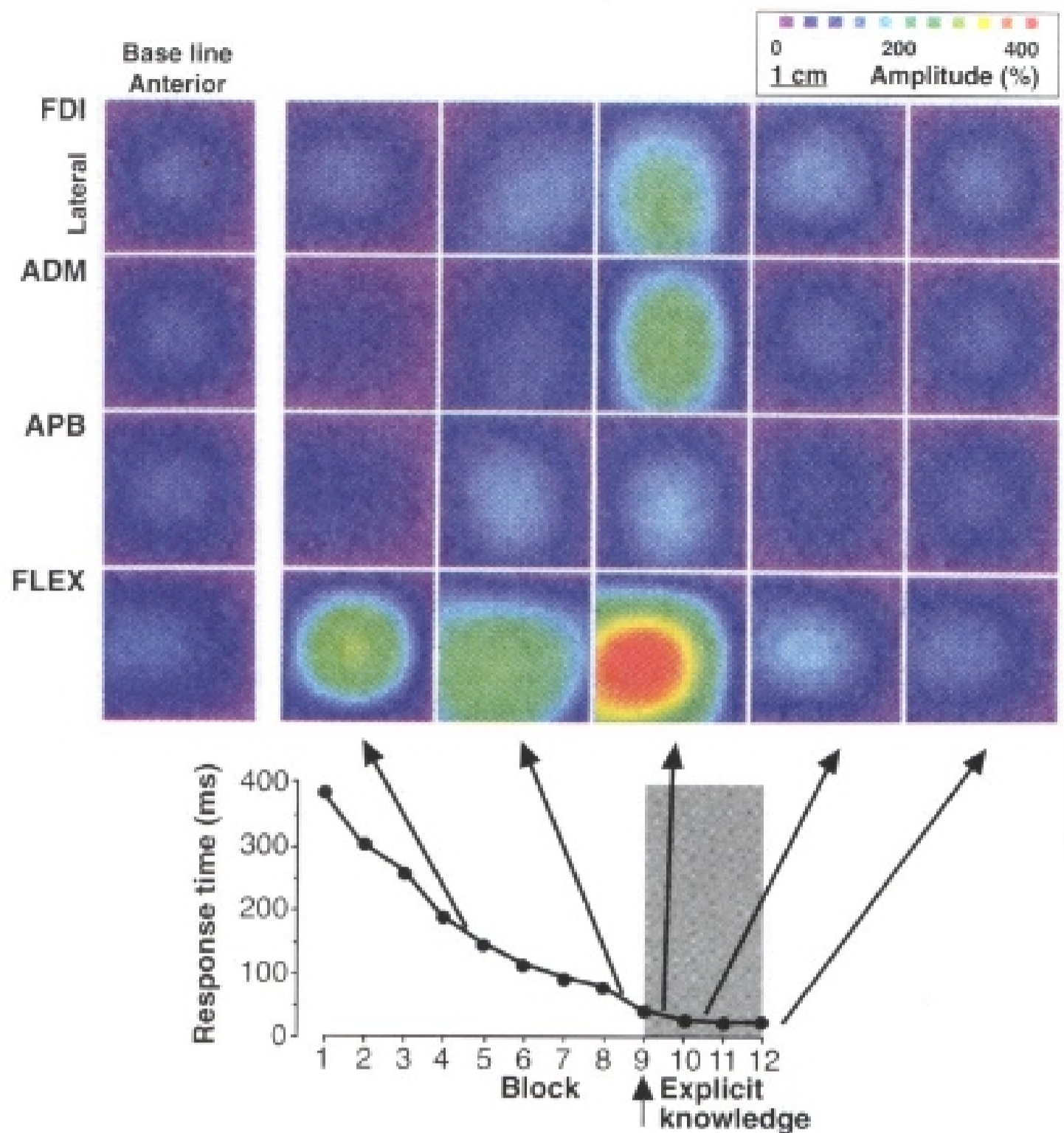
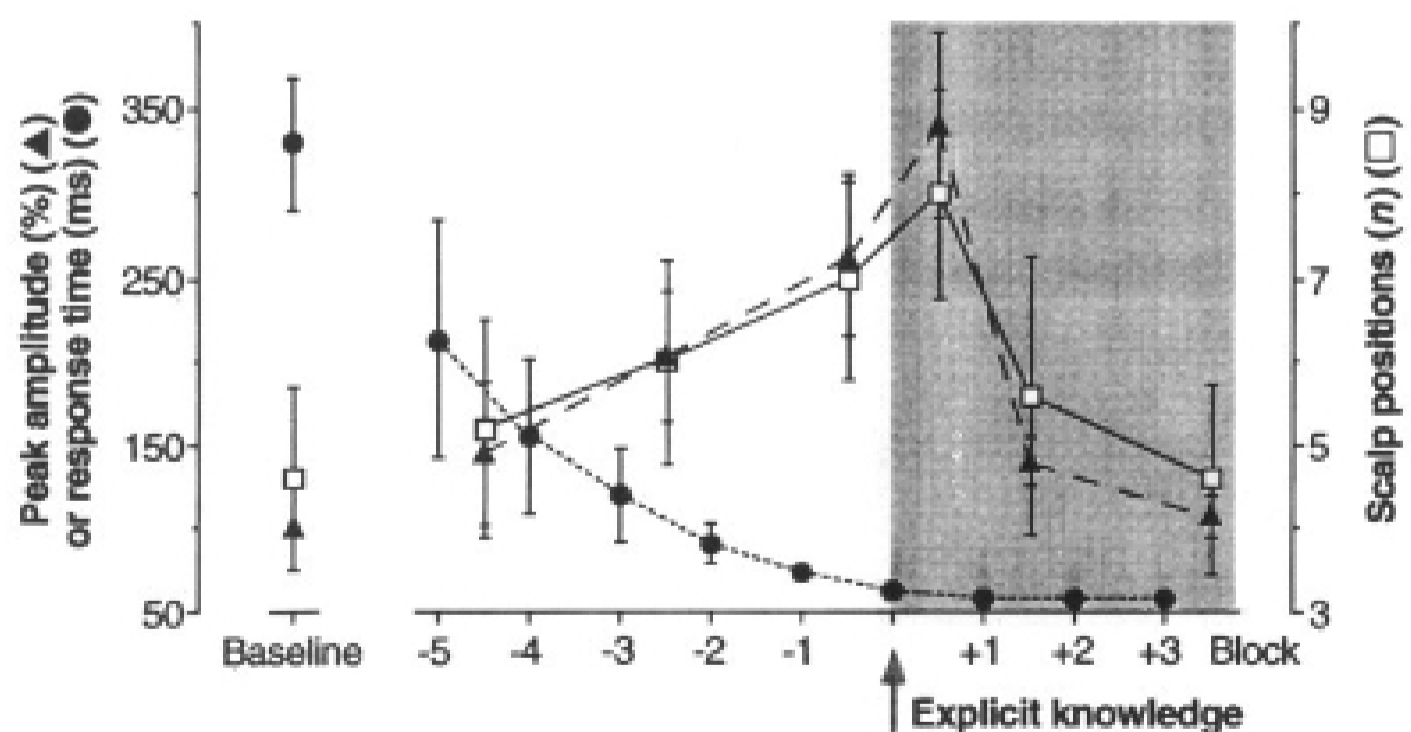


**Fig. 1.** Response times on the SRTT and cortical motor output maps for all muscles tested in a single representative test subject. Complete explicit knowledge of the sequence is achieved after block 9 (arrow). The baseline motor output maps were obtained before the beginning of the SRTT; the other maps after blocks 4, 8, 9, 10, and 12 of the SRTT (arrows), when subjects were at rest. The maps represent contour plots of the amplitude of the TMS-induced muscle response as a percentage of the maximal MEP generated over the optimal position at the baseline. Each map encompasses an area of 5 by 5 cm centered over the optimal position for activation of each muscle (8).



**Fig. 2.** Response times on the SRTT and peak amplitude and number of scalp positions of the cortical motor output maps for the FLEX muscle from which TMS evoked MEPs of  $\geq 60\%$  of the peak amplitude at the baseline. The values express mean  $\pm$  SD for the five test subjects after alignment of their results to the block during which they achieved explicit knowledge of the sequence. Baseline values correspond to the cortical output maps obtained before the SRTT and to the SRTT performance in the first block of trials. Negative numbers on "block" axis are numbers of blocks seen before explicit knowledge was achieved.

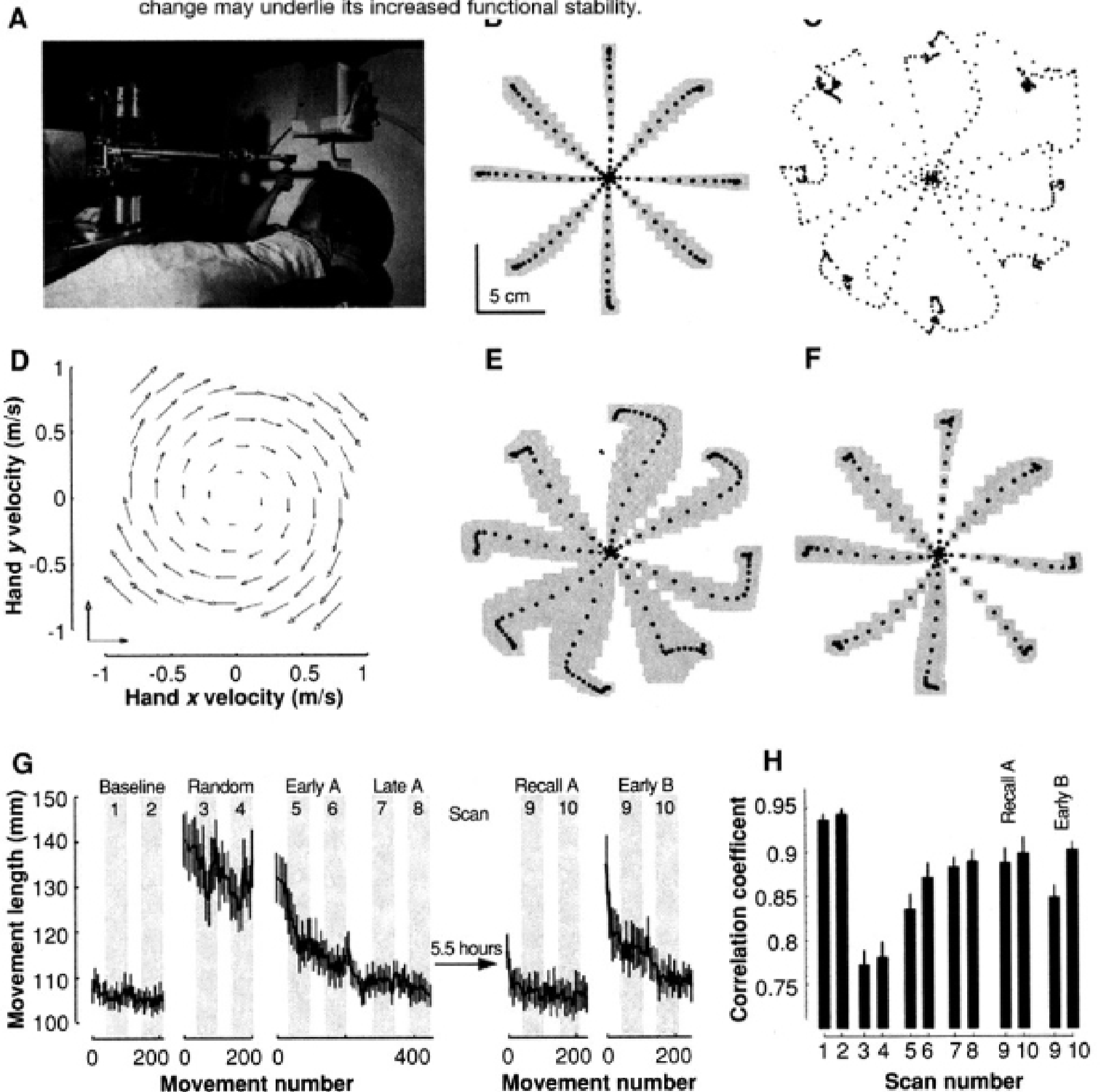


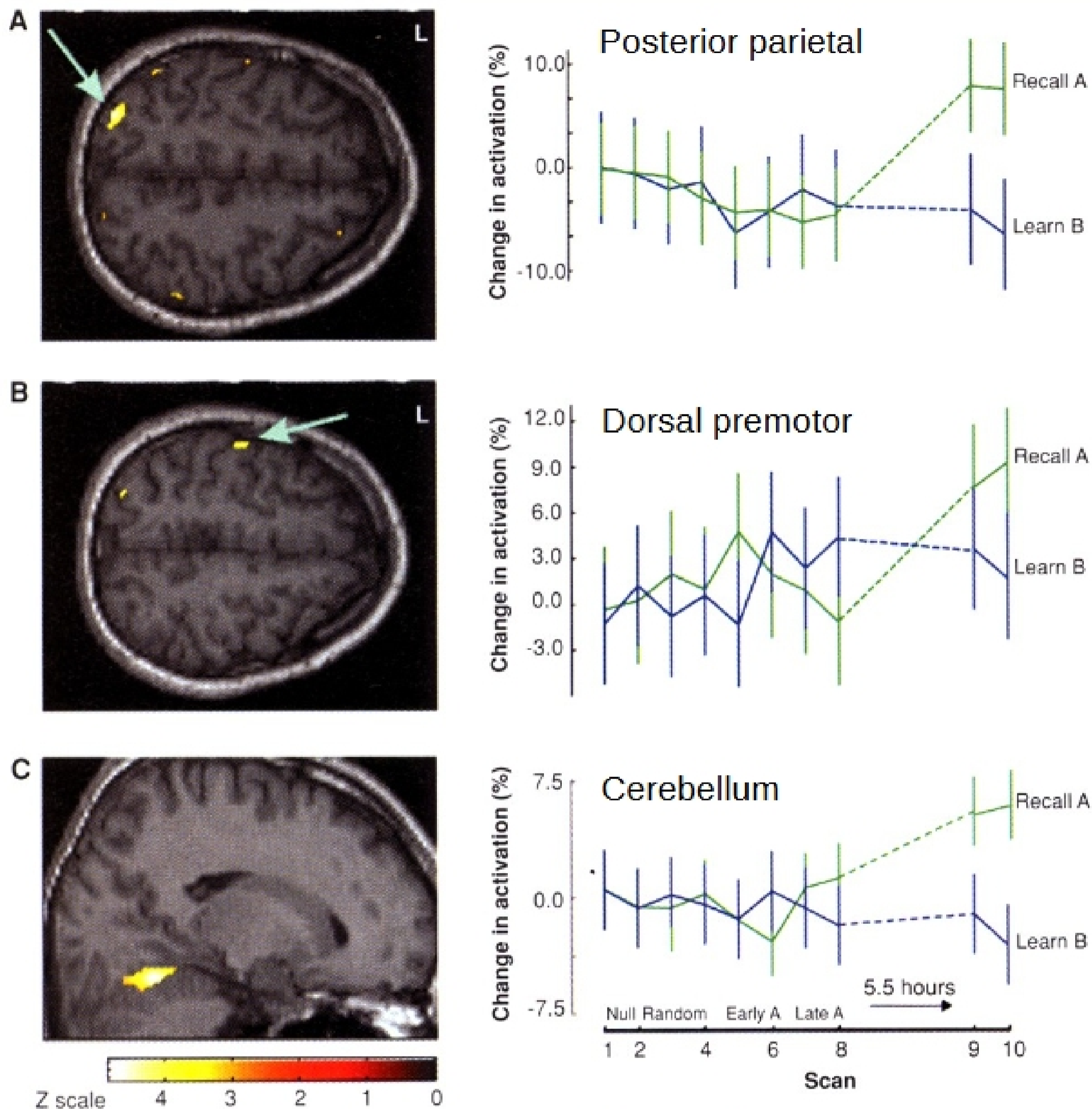
Pascual-Leone A, Grafman J, Hallett M. (1994) Modulation of cortical motor output maps during development of implicit and explicit knowledge. *Science* 263:1287.

# Neural Correlates of Motor Memory Consolidation

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Computational studies suggest that acquisition of a motor skill involves learning an internal model of the dynamics of the task, which enables the brain to predict and compensate for mechanical behavior. During the hours that follow completion of practice, representation of the internal model gradually changes, becoming less fragile with respect to behavioral interference. Here, functional imaging of the brain demonstrates that within 6 hours after completion of practice, while performance remains unchanged, the brain engages new regions to perform the task; there is a shift from prefrontal regions of the cortex to the premotor, posterior parietal, and cerebellar cortex structures. This shift is specific to recall of an established motor skill and suggests that with the passage of time, there is a change in the neural representation of the internal model and that this change may underlie its increased functional stability.





**Fig. 3.** Brain regions showing a significant increase in rCBF from the learning stage of field A to recall of field A at +5.5 hours. The regions are shown on the normalized MRI of a typical participant (18). **(A)** Transverse view of an area in the left posterior parietal cortex (peak location at  $-30, -78, 54$ ; BA 7;  $Z = +4.95$ ; late A versus recall A) and the peak location's changes in rCBF with respect to the null field (mean 95% CI). Shown also are the changes in rCBF from the group of participants that learned a novel field B at +5.5 hours. **(B)** Transverse view of an area of activation in the left dorsal premotor cortex ( $-50, -16, 60$ ; BA 6;  $Z = +3.74$ ; late A versus recall A). **(C)** Sagittal view of an area of activation in the right anterior cerebellar cortex ( $18, -60, -20$ ;  $Z = +4.93$ ; early A versus recall A). The increased activations in these regions were specific to recall of the recently acquired IM of field A.