Lesion of right dorsolateral prefrontal cortex affects motor habit but not motor performance itself in monkeys performing manual dexterity tasks

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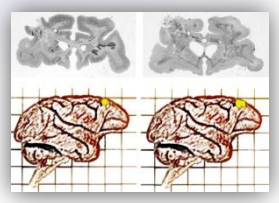
INTRODUCTION AND METHODS

In the context of an autologous cell transplantation study (Kaeser et al., 2011, Neurosurgery 68: 1405-1417), a unilateral biopsy of cortical tissue was performed surgically in the right dorsolateral prefrontal cortex (dlPFC) of two adult macaque monkeys (Mk-JO and Mk-AV).

As different studies have shown a clear implication of dlPFC in different cognitive functions, we may expect a possible effect of right dlPFC biopsy on the performance of monkeys engaged in sequential manual dexterity tasks.

We hypothesized that dlPFC lesion had no effect on motor control per se but may affect the motor habit of the monkeys, namely the temporal order to grasp pellets from different spatial locations.

The monkeys were anaesthetized under sterile surgical conditions. A square osseous sector was opened above the dlPFC. Then, an approximate volume of 8-20 mm^3 cortical tissue was extracted using a surgical blade.

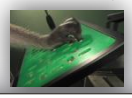


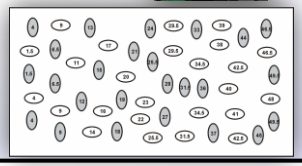
During the same surgery, an electrophysiological recording chamber was implanted on the skull above the primary motor cortex (M1) in the opposite hemisphere. Three additional monkeys (Mk-JA, Mk-VA and Mk-SL) subjected to the same chamber implantation but without biopsy in dlPFC at the same time were used as controls.

Monkeys were initially trained to perform two unimanual prehension tasks requiring precision grip (assessment of manual dexterity).

Modified Brinkman Board task

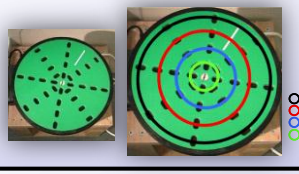
It contains 25 vertically and 25 horizontally oriented and randomly distributed wells, which were numerated.





Rotating Brinkman Board task

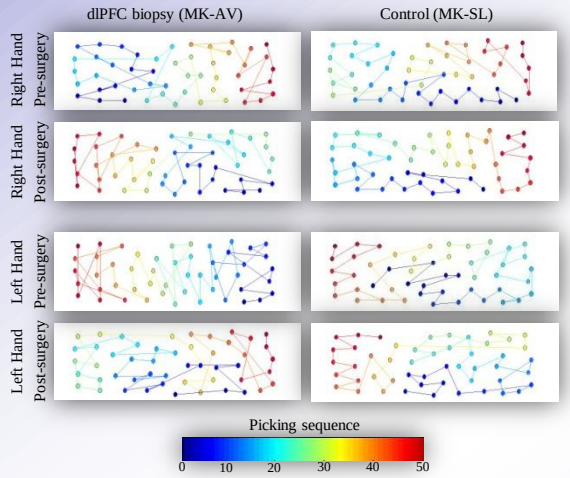
It contains 32 wells, with orientations corresponding to vertical and horizontal positions when the wells are in front of the monkey, and organized in four rings numerated from the most external to the most internal ring.



RESULTS

A

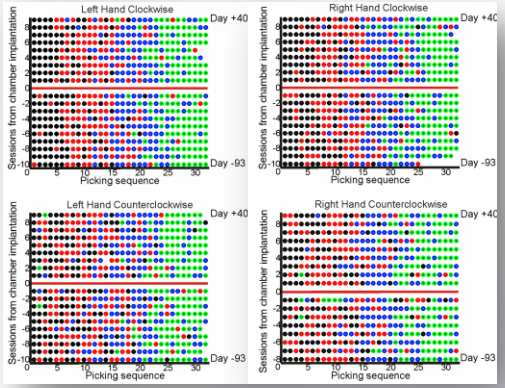
Modified Brinkman Board task
Representative sessions



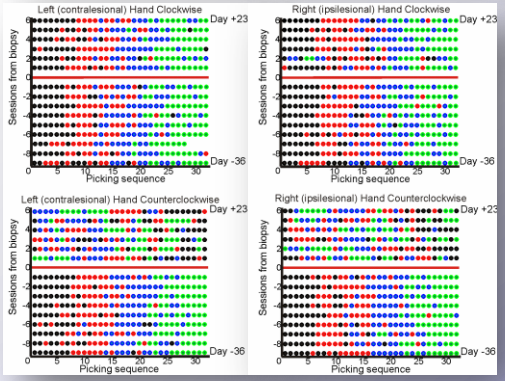
B

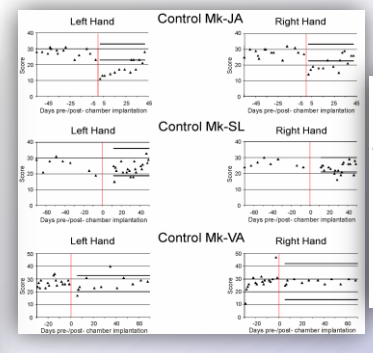
Rotating Brinkman Board task

Control Mk-JA



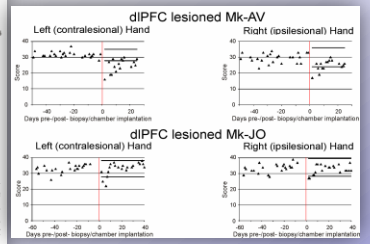
dlPFC lesioned Mk-AV



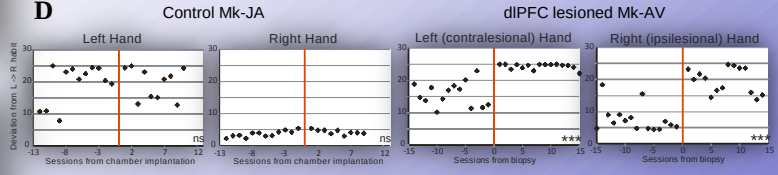


C

Modified Brinkman Board Score



D



Following the surgery, transient and moderate deficits of manual dexterity per se occurred in both groups (panel C), indicating that they were not due to the dlPFC lesion (most likely related to the recording chamber implantation and/or general anaesthesia/medication). In contrast, changes of motor habit were observed for the sequential order of grasping only in the two monkeys with dlPFC lesion (panels A, B and D). Panel D is a quantitative assessment of the prehension sequence (modified Brinkman board task), exhibiting a statistically significant difference in Mk-AV (dlPFC lesion), but not in Mk-JA (control). Comparable data were obtained in Mk-JO as in Mk-AV, but to a somewhat lesser extent, in line with a smaller dlPFC lesion.

DISCUSSION

The changes in motor habit were more prominent in the monkey subjected to the largest lesion, supporting the notion of a specific effect of the dlPFC lesion on the prehension's sequence of the monkeys.

These observations are reminiscent of previous studies using conditional tasks with delay that have proposed a specialization of the dlPFC for visuospatial working memory, except that this is in a different context of "free-will", non conditional manual dexterity task, without a component of working memory (motor habit).

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