Further Evidence of Impaired Tactile Learning after Removals of the Second Somatic Sensory Projection Cortex (SII) in the Monkey

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Summary. Four rhesus monkeys with bilateral removals of SII and five unoperated monkeys were trained on tests of tactile equivalence, weight discrimination and generalization, tactile discrimination learning (including concurrent learning and serial reversal) and inter-manual transfer of tactile learning. Lesioned animals were impaired on almost all tactile learning tasks and on inter-manual transfer but not on the test of tactile equivalence nor on the proprioceptive tasks. The results are considered in the context of previous studies of somatosensory and parietal cortex.

Key words: Second somatosensory projection cortex – Tactile discrimination learning

Although changes in tactile performance were not observed to follow removals of the second somatosensory cortex (SII) in monkeys by Orbach and Chow (1959), we have recently reported (Ridley and Ettlinger, 1976) that monkeys with intended bilateral removals of SII were severely impaired at tactile learning and retention but showed no change in tactile sensitivity and were not impaired on a visual discrimination task. We now report tests of tactile equivalence, weight discrimination and generalization, inter-manual transfer and tactile new learning using the animals already studied in Ridley and Ettlinger (1976), and we describe the extent of the lesions in two animals. The remaining animals are currently being used in further behavioural training.

Methods

Subjects. The subjects of this experiment were 9 rhesus monkeys (Macaca mulatta) used by Ridley and Ettlinger (1976). On the basis of their performance on an unfamiliar tactile discrimination task (stage 1 of Ridley and Ettlinger, 1976) monkeys had been allocated to two balanced groups. One group (animals SII-1 to SII-4) received bilateral ablations of SII. The remaining group (animals C-1 to C-5) were unoperated.
Histology. At the completion of training the lesioned animals which had shown the best and worst overall tactile learning performance (SII-2 and SII-4) were anaesthetized and perfused with saline and formalin after which the brains were removed. Figure 1 shows the extent of the cortical removals on the lateral surfaces in these 2 animals. Serial coronal sections of 25 µm thickness were cut and every 20th section was stained with thionine. As can be seen in the cross-sections of Figure 2, the surgical intentions were largely achieved. In some sections some of the medial facing surface of the upper bank of the Sylvian fissure was left intact. Rarely, the lesion penetrated too far medially into white matter or into insular cortex. In both animals the extent of the lesions on the lateral surface (i.e. dorsal to the Sylvian fissure) was greater than would have been appropriate by reference to the subsequent publication by Burton and Jones (1976). No unequivocal gliosis could be detected anywhere in the thalamus of either brain.

Training Procedures and Apparatus. The animals were trained in a modified Wisconsin General Test Apparatus, according to a pseudo-random Gellermann Schedule, all tasks being given in the dark except weight training where minimal light was available. A correct response was rewarded with a peanut. 40 trials were given each day, 4 or 5 days each week. During performance in the dark the animals' movements could be observed by use of an infra-red image convertor system. Routinely, the infra-red illumination was switched off, but observations were systematically taken during performance at criterion. Unless otherwise stated, animals were trained to a criterion of 90 correct responses in 100 successive trials (90/100); choice of the first member of each pair of test-objects was rewarded.

Sequence of Training

Stage 1. Post-Operative Performance on a Tactile Equivalence Task. Immediately after learning to discriminate between a triangle and a disc (see stage 10 of Ridley and Ettlinger, 1976), animals were tested on the equivalence of new test-objects which resembled the original test-objects in certain features. All test-objects were fastened to the lids of 2 large food boxes. Details of the equivalence task design are described in stage 5 of Ridley and Ettlinger (1975). Briefly, all animals were initially adapted (criterion 45/50) to receiving 7 rewards for 10 correct responses using the original triangle and disc test-objects. Then 512 trials of equivalence testing were given, comprising, in 32 trials each day, 8 unrewarded “equivalence” trials randomly placed among 24 rewarded “training” trials for which both of the original test-objects were used. On an equivalence trial one of the original test-objects was paired with one of 8 new objects. The original test-objects differed in 4 features: