Somatosensory decision-making in the head-fixed mouse.

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We developed a simple somatosensory discrimination task for head-fixed mice. Mice used their whiskers to judge the absolute distance to a small pole presented on one side of their head. Mice were trained to indicate a target (“go”) position by licking for a water reward. When the pole was in a distracter (“no-go”) position mice had to withhold a licking response to avoid an aversive airpuff.

After optimization of training parameters all mice (n=7) reached criterion performance (85% correct) in 7-14 daily sessions. Learning occurred both within and between sessions. Once trained, mice performed about 200-500 trials per session (~50 min); individual mice performed at high levels (> 90%) for months.

To facilitate high-speed whisker tracking, we trimmed whiskers down to a single row or fewer. Mice performed at high levels even with a single whisker. Stimulus sampling was associated with stereotyped and asymmetric whisking patterns.

With all whiskers trimmed, trained mice performed at chance levels (51 ± 2% correct, n=3 mice), indicating that mice solved the task with their whiskers rather than relying on other sensory cues.

We varied the difficulty of the task by decreasing the distance between the go and no-go positions, obtaining psychometric-style curves. Mice with full whisker fields (n=3 mice) or a single row (n=1 mouse) were able to determine distance to better than 0.95 mm (~ 6 degrees of whisker angle).

Silencing contralateral barrel cortex using muscimol injections reversibly reduced performance to chance levels (53 ± 2% correct, n=3 mice); silencing of the visual cortex had little effect (95 ± 0.2% correct, n=2 mice). Furthermore, ablation lesions of somatosensory cortex contralateral to the whisker stimulus brought performance to chance levels (50 ± 3% correct, n=3 mice), whereas performance remained unaffected with a similar lesion applied to the ipsilateral hemisphere. These experiments indicate that our discrimination task depends critically on somatosensory cortex.

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