Behavioural Brain Research 237 (2013) 238–242

Contents lists available at SciVerse ScienceDirect

Behavioural Brain Research

journal homepage: www.elsevier.com/locate/bbr

Short communication

Novel, whisker-dependent texture discrimination task for mice

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HIGHLIGHTS

- We created a novel task to assess whisker-dependent texture discrimination in mice.
- Our novel texture discrimination task does not require food or water deprivation.
- 3 days and 1 h handling time, per subject, over the entire testing period is required.
- Mice can discriminate between textures separated by 25 μm in particle diameter.
- Texture discrimination in mice is dependent on intact mystacial vibrissae.

ARTICLE INFO

Article history:
Received 20 August 2012
Received in revised form
21 September 2012
Accepted 23 September 2012
Available online 28 September 2012

Keywords:
Texture discrimination
Mystacial vibrissae
Mice behavior
Whisker sensitivity

ABSTRACT

Many mammals use their mystacial vibrissae to palpate objects in their environment and encode information such as size, shape and texture. We have developed a novel method to assess the sensitivity with which mice can discriminate textures using their mystacial vibrissae. Our texture discrimination task can be performed within 3 days, requiring approximately 1 h of handling time, per subject, over the entire testing period. No appetitive or aversive training is required. We have demonstrated that this novel texture discrimination task is dependent on intact mystacial vibrissae and can be performed by both young (2-month old) and older (6-month old) C57BL/6 mice. The parameters of the task can be adjusted to assess the sensitivity of mice using a gradient of textures with different roughness. We have developed a novel, efficient method to assess whisker-mediated texture discrimination in mice.

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Rodents rely on their whiskers to acquire much of the information in their environment. This includes the size, shape, and texture of objects the rodents come in contact with [1]. The barrel cortex is devoted to the processing of sensory input from the facial whiskers and occupies approximately 70% of the primary somatosensory cortex of rodents [2,3]. Sensory input from one mystacial vibrissa can be traced with specificity to a defined area of the barrel cortex [3]. The barrel cortex system of rodents has been exploited by neuroscientists to examine a wide variety of questions within cellular and systems neuroscience, including cortical map development, cortical plasticity, and neuronal encoding of sensory stimuli [1,4,5]. Where genetic factors are involved, the mouse barrel cortex has been particularly valuable. Many of the studies conducted within the barrel cortex system can be further expanded to observe how the experimental parameters applied can ultimately affect whisker function and whisker-mediated behavior. Here we describe a task developed specifically to test the whisker sensitivity of mice.

Existing tasks that assess whisker function in mice can be separated into two categories, head-fixed and freely moving tasks. Head-fixed tasks involve precisely tracking whisker movement with the mouse's head immobilized using implanted rods [6–8]. The immobilized mouse is trained to perform a discrimination task using its whiskers in a go/no go task with reward from a waterspout. Approximately 10 training sessions are required to reach a criterion of 85% correct responses. Freely moving tasks generally consist of training rodents in a Y- or T-maze type enclosure to navigate to the goal arm for a food reward [9–13]. The cue for the goal arm is presented at the junction of the two arms and may consist of textures presented across a gap. The mouse is required to palpate the cue with its whiskers prior to navigating across the gap to the baited arm. Training for these tasks typically requires more than 5 sessions, with each session typically consisting of more than 20 trials.

Although the use of mice in neuroscience research is widespread, behavioral assessment in mice largely involves the use of miniaturized equipment that are originally tailored to rats and may not be effective for use with mice [13]. Training mice typically requires many trials spread across multiple sessions and significant time commitment for each mouse. Food or water deprivation are

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http://dx.doi.org/10.1016/j.bbr.2012.09.044

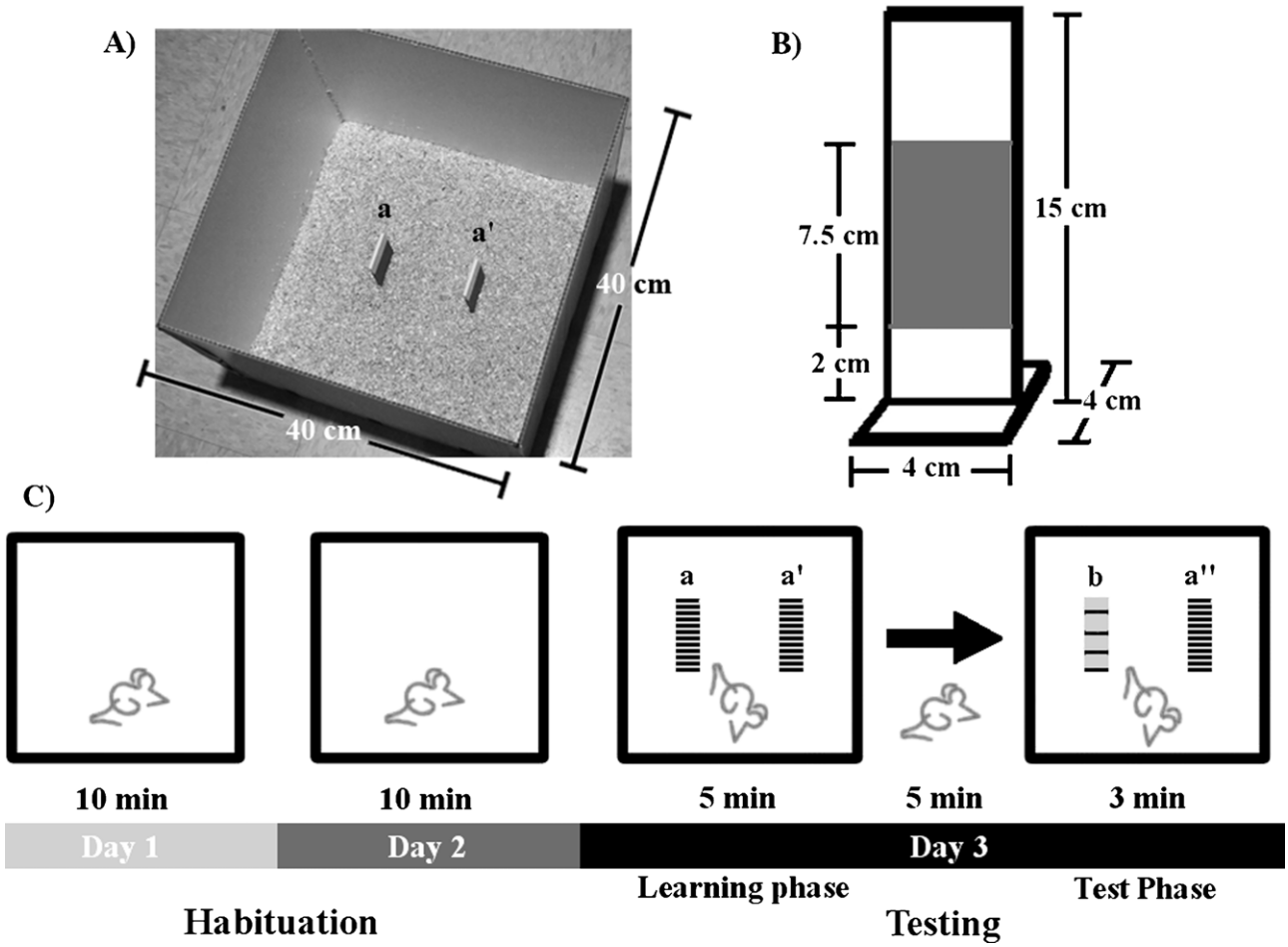

Fig. 1. Schematic of the texture discrimination task. (A) Photograph of the testing apparatus. (B) Schematic of the discriminanda. (C) Schematic of the procedure for the texture discrimination task. (a, a′, and a″) 3 objects with identical textures; (b) novel object with a different texture to object A.

also required to motivate mice to perform baited tasks. This not only increases the time required to prepare a mouse for testing, but also introduces motivation as another variable that must be accounted for.

In the present study, we demonstrate a novel approach to assess whisker sensitivity in mice. This task does not require food or water rewards, surgery, or extensive commitment in time and equipment. We modified the novel object recognition task [14] to create a whisker-dependent texture discrimination task that can be performed in 3 days with less than 1 h of training/testing (in total) per mouse.

Male, C57BL/6 mice at the ages of 2 and 6 months were used for this study. The mice were maintained on standard laboratory diet and water ad libitum and kept in standard laboratory housing under a 12-h light/dark cycle. A whisker-less group was generated to test for the specificity of the texture-discrimination task to the presence of whiskers. Mice were placed under isoflourane anesthesia and all mystacial vibrissae were removed with tweezers. Carefully done, the plucking of whiskers does not damage the whisker follicles, allowing them to regrow. The bilateral removal of the mystacial vibrissae was performed 3 days prior to the start of testing. All procedures were approved by the Animal Care Committee of the University of Calgary and conformed to the guidelines set out by the Canadian Council for Animal Care.

The testing arena was constructed with white corrugated plastic boards (Plaskolite Inc., Ohio) and measured 40 cm × 40 cm × 40 cm high (Fig. 1A). The base of the arena was carpeted with 2 cm of standard laboratory bedding (Aspen Chip; Nepco, Warrensburg, NY). The target objects used for the texture discrimination task were constructed with rectangular 0.5 cm thick corrugated plastic boards, 4 cm × 15 cm high, fixed to a 4 cm × 4 cm base (Fig. 1B). Aluminum oxide sand paper (Gator Finishing Products, Ohio) was affixed to the faces of these upright boards such that the sand paper covered 7.5 cm of the height of the boards starting 2 cm from its base. Different grades of sand paper (80, 100, 120, and 220 grit) were used to create a series of objects that were mainly distinguishable through texture. The roughness of the texture was determined by the average particle diameter of the sandpaper (approximately 190 μm, 140 μm, 115 μm, and 70 μm). Three identical objects were created for each grade of sandpaper used in this study to avoid repeated use of the same object across the testing period. This minimized the possibility that the mice recognized one particular object using olfactory cues.

Plastic transparency film (3 M, London, Ontario) was used to cover the faces of the texture discrimination objects to create smooth objects differentiated by the subtle visual differences between the different grades of sandpaper used. The transparent film-covered, “texture-less”, objects were used to test the mouse’s ability to visually differentiate between the textures. The use of the texture-less objects was included in the study as a means to account for visual cues contributing to the discrimination.

The mice were habituated to the testing arena prior to the texture discrimination task. The habituation period was required to acclimatize the mice to the testing arena and promote exploratory behavior on the testing day. Illumination was provided with two 150 W overhead incandescent floodlights dimmed to

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