Data Article

Dataset of reaching behavior for reward in social situations in mice

Masatoshi Ukezono\textsuperscript{a,b}, Yuji Takano\textsuperscript{c,*}

\textsuperscript{a} Department of Neuropsychopharmacology, National Institute of Mental Health, National Center of Neurology and Psychiatry, Kodaira, Tokyo, Japan
\textsuperscript{b} Medical Science Innovation Hub Program, RIKEN, Yokohama, Kanagawa, Japan
\textsuperscript{c} Smart-Aging Research Center, Tohoku University, Sendai, Miyagi, Japan

A R T I C L E   I N F O

Article history:
Received 12 November 2020
Revised 12 January 2021
Accepted 15 January 2021
Available online 30 January 2021

Keywords:
Mirror neuron system
Intention understanding
Reaching behavior
Observation

A B S T R A C T

The data presented in this article is from a paper entitled “An experimental task to examine the mirror neuron system in mice: Laboratory mice understand the movement intentions of other mice based on their own experience” (Ukezono and Takano, 2021). This article contains individual data on reaching behavior for reward in social situations in mice. In the reaching room, the mice first learned how to acquire food by reaching their limbs. The mice that had learned reaching were placed in an observation room where they could observe the reaching activity of another mouse in the reaching room. The data includes all animals’ properties and conditions, the pairing state of another mouse (cage mate or non-cage mate), and a set of behavioral analyses. Our data have the potential to be reused for analyzing interaction behaviors of mice placed in front of rewards and developing experiments for behavioral neuroscience research on the mirror neuron system in mice.

© 2021 The Author(s). Published by Elsevier Inc. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/)

DOI of original article: 10.1016/j.bbr.2020.112970
* Corresponding author.
E-mail address: yuji.takano.a6@tohoku.ac.jp (Y. Takano).
Specifications Table

| Subject                        | Behavioral neuroscience |
|-------------------------------|-------------------------|
| Specific subject area         | Mirror system           |
|                               | Reaching behavior       |
|                               | Observation             |
| Type of data                  | Table, figure           |
| How data were acquired        | Data were collected using a reaching behavior task. The apparatus, which included a reaching room and an observation room, was made of a transparent acrylic, with a feeding table between the two sides. In the reaching room, a slit (10 mm) was created near the feeding table to allow the mice to reach for and grasp a piece of pasta, which served as a food reward. We placed two video cameras, one above and another in front of the apparatus, and recorded the animal behaviors (60 fps). |
| Data format                   | Raw and analyzed        |
| Parameters for data collection| Data were collected from 32 C57BL/N male mice in Experiment 1 and 50 C57BL/N male mice in Experiment 2. We recorded the behavior of the mice while they observed the reaching behavior in conspecifics under different conditions, manually categorized the behavior, measured the speed by stopwatch, and measured the approach time by stopwatch. |
| Description of data collection| The behavioral data were collected in the same room. We placed two video cameras, one above and another in front of the apparatus, and recorded the animal behaviors (60 fps) during the learning of the reaching behavior and test session. |
| Data source location          | Institute for Animal Experimentation Tohoku University Graduate School of Medicine. |
|                               | City/Town/Region: Sendai-shi, Miyagi |
|                               | Country: Japan           |
| Data accessibility            | Data is accessible from this article and the following data repositories. |
|                               | Experimental videos of Experiment 1 and Experiment 2, which were used for our manual judgment, have been uploaded to the data repository site. |
|                               | Repository name: Zenodo  |
|                               | Direct URL to data of Experiment 1 in test session: |
|                               | https://zenodo.org/record/4286071#.X9WYstj7Q2w |
|                               | And Experiment 2 in test session: |
|                               | https://zenodo.org/record/4287815#.X9WaMNj7Q2w |
| Related research article      | Ukezono, M., and Takano, Y. (2021). An experimental task to examine the mirror neuron system in mice: Laboratory mice understand the movement intentions of other individuals through their own experience, Behavioral Brain Research. 398, 112970. |
|                               | https://doi.org/10.1016/j.bbr.2020.112970 |

Value of the Data

- This is a valuable dataset because mice that have learned reaching behaviors paid attention to, were in close proximity with, and observed mice demonstrating reaching behaviors of other individuals, allowing for additional analysis of these behaviors. In addition, the full data for each mouse is provided so that the reader can refer to the individual learning process.
- The data on mice paying attention to other individuals and observational learning in mice will be useful to psychologists in the learning and social fields. It is also a useful dataset for behavioral neuroscientists as it can be used to record neural activity during this experimental task.
- As it is possible to analyze how reaching behavior changes depending on whether the mouse has learned the behavior or not, this dataset can provide insight into understanding intentions and help propagate research in this field, including research on the mirror neuron system.

1. Data Description

The data presented in this article is from a paper entitled “An experimental task to examine the mirror neuron system in mice: Laboratory mice understand the movement intentions
of other mice based on their own experience” (Ukezono and Takano, 2021). This article contains data on reaching behavior for reward in social situations of individual mice. In addition, there is information on training time and data on the follow-up elements of Experiment 1 and Experiment 2, and these data were not provided in the previous paper [1].

In Experiment 1, we assessed whether a mouse observed the reaching behavior of other individuals after it learned to reach for food. As a control condition, we assessed the behavior of mice that had not learned to reach and determined whether they observed the reaching behavior of other individuals.

Fig. 1 shows the characteristics of each mouse and the experimental schedule, and Table 1 shows the detailed characteristics of all 32 mice in Experiment 1. After finishing training, behavioral tests were conducted for pairs, and the combinations were cage mate or non-cage mates. In the test, we had the learned reaching group (Learning group) and the unlearned group (Unlearning group) observe another individual’s reaching behavior for food.
Table 1
The characteristics of all mice in Experiment 1.

| ID       | Condition | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 | Session 7 | Test |
|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------|
| ex2_mouse1 | Learning | 1200 | 1200 | 1200 | 1200 | 1109 | 768 | 555 | 401 |
| ex2_mouse2 | Learning | 1200 | 1200 | 1200 | 1200 | 898 | 560 | 733 | 650 |
| ex2_mouse3 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1091 | 1057 | 1191 | 603 |
| ex2_mouse4 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 755 | 603 |
| ex2_mouse5 | Empty | 1200 | 1200 | 1200 | 1200 | 1042 | 571 | 534 | 603 |
| ex2_mouse6 | Empty | 1200 | 1200 | 1200 | 1200 | 815 | 770 | 502 | 603 |
| ex2_mouse7 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1037 | 907 | 605 |
| ex2_mouse8 | Empty | 1200 | 1200 | 1200 | 1200 | 784 | 760 | 578 | 697 |
| ex2_mouse9 | Learning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1181 | 603 |
| ex2_mouse10 | Learning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1199 | 603 |
| ex2_mouse11 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 603 |
| ex2_mouse12 | Empty | 1200 | 1200 | 1200 | 1200 | 895 | 429 | 376 | 603 |
| ex2_mouse13 | Empty | 1200 | 1200 | 1200 | 1200 | 808 | 890 | 754 | 536 |
| ex2_mouse14 | Empty | 1200 | 1200 | 1200 | 1200 | 740 | 801 | 715 | 557 |
| ex2_mouse15 | Empty | 1200 | 1200 | 1200 | 1200 | 1041 | 775 | 619 | 603 |
| ex2_mouse16 | Empty | 1200 | 1200 | 1200 | 1200 | 1013 | 595 | 1195 | 603 |
| ex2_mouse17 | Empty | 1200 | 1200 | 1200 | 1200 | 750 | 487 | 389 | 603 |
| ex2_mouse18 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 851 | 581 | 603 |
| ex2_mouse19 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 964 | 543 |
| ex2_mouse20 | Empty | 1200 | 1200 | 1200 | 1200 | 753 | 1014 | 531 | 553 |
| ex2_mouse21 | Empty | 1200 | 1200 | 1200 | 1200 | 637 | 483 | 603 |
| ex2_mouse22 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 628 | 603 |
| ex2_mouse23 | Empty | 1200 | 1200 | 1200 | 1200 | 671 | 481 | 603 |
| ex2_mouse24 | Empty | 1200 | 1200 | 1200 | 1200 | 1043 | 748 | 603 |
| ex2_mouse25 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 393 | 401 |
| ex2_mouse26 | Empty | 1200 | 1200 | 1200 | 1200 | 854 | 845 | 650 |
| ex2_mouse27 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse28 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse29 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse30 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse31 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse32 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse33 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse34 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse35 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse36 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse37 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse38 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse39 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse40 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse41 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse42 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse43 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse44 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse45 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse46 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse47 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse48 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse49 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |
| ex2_mouse50 | Empty | 600 | 600 | 600 | 600 | 600 | 600 | 600 |

Table 2 shows the success rate of reaching for each mouse during training sessions 3 to 7 in Experiment 1. The reason for omitting sessions 1 and 2 is that during these sessions the mice were only trained to reach and grasp for the pasta with their forepaws. The success rate was calculated by dividing the number of successful reaching attempts by the total number of trials in a session, which was 20. Successful reaching was defined as reaching for and grasping a piece of pasta and eating it.
To eliminate behaviors other than reaching, the mice were trained to turn around on the spot before reaching. Table 3 shows the spinning time in session 7 (no observer), unlearning observer in the test session, and learning observer in the test session. Previous studies have used an analysis of the difference in spinning time to indicate the effects by the presence or absence of social perception between two individuals [1-2].

Fig. 2 and Fig. 3 show the examples of “face to face” and “not paying attention” behavior of the observer mouse in the test session in Experiment 1. From the data in the video, we manually grouped the observer’s behavior into three categories: “face to face,” “ambiguous,” and “not paying attention.” The videos on which these ratings are based on are accessible from the sites noted in the Data accessibility section. “Face to face” was noted when the two heads were in a straight line in videos captured by the side and upper cameras. “Not paying attention” was noted when the observer was looking away, beyond 90°, from the partner that was reaching for a pasta independent of position. “Ambiguous” was noted when the situation did not fit the definition of “face to face” or “not paying attention.”

Table 4 (Learning group) and Table 5 (Unlearning group) are the coded data of the observing individuals' behavior when the reaching individual was reaching during the test session. While the other mouse was reaching, we categorized the observer's behavior as “face to face,” “am-
Fig. 2. Example of “face to face” behavior observed using the side and upper camera. The first picture indicates the starting of spinning and is set to 0 sec. Reaching behavior was performed after the end of the spin, and at the moment when the mouse touched the pasta, the observer’s behavior was classified into the following three categories: “face to face,” “ambiguous,” or “not paying attention.” The “face to face” behavior is defined as the two heads being in a straight line at the time of reaching behavior.

Fig. 3. Example of the “not paying attention” behavior as observed from the side and upper cameras. “Not paying attention” behavior was defined as the observer looking away, beyond 90°, from the slit.

Table 6 (Individual data) and Fig. 4 (Averaging data) show the amount of time mice spent near the slit in the observation room during the test session in Experiment 1. When the animal was on the slit side in the middle of the observation box, we defined it as being close to the slit. The amount of time the observer’s position was close to the slit, as seen from the upper camera, was determined. The frequency of near position by observer was calculated by dividing the time close to the slit by the total time of the experiment for the Learning group (mean = 58.1%, standard deviation [SD] = 10.69) and Unlearning group (mean = 48.4%, SD = 11.83). We compared the rate of observer position between the Learning and Unlearning groups. This comparison was significant ($t'(30) = 2.35, p < 0.05$).
The shows orior condition individuals, 1, training tal apparatus Unlearning tetween total experiment was in searching for other characteristics of mice in the Learning group in Experiment 1.

| ID      | Condition | F to F | Ambiguous | Not paying attention |
|---------|-----------|--------|-----------|----------------------|
| mouse1  | Learning  | 0%     | 50%       | 50%                  |
| mouse2  | Learning  | 35%    | 35%       | 30%                  |
| mouse3  | Learning  | 65%    | 15%       | 20%                  |
| mouse4  | Learning  | 30%    | 20%       | 50%                  |
| mouse5  | Learning  | 0%     | 55%       | 45%                  |
| mouse6  | Learning  | 25%    | 20%       | 55%                  |
| mouse7  | Learning  | 30%    | 20%       | 50%                  |
| mouse8  | Learning  | 25%    | 25%       | 50%                  |
| mouse9  | Learning  | 30%    | 25%       | 45%                  |
| mouse10 | Learning  | 15%    | 45%       | 40%                  |
| mouse11 | Learning  | 25%    | 35%       | 40%                  |
| mouse12 | Learning  | 35%    | 25%       | 40%                  |
| mouse13 | Learning  | 25%    | 30%       | 45%                  |
| mouse14 | Learning  | 30%    | 30%       | 40%                  |
| mouse15 | Learning  | 10%    | 40%       | 50%                  |
| mouse16 | Learning  | 20%    | 25%       | 55%                  |

Table 5 Frequency of each behavioral category for mice in the Unlearning group in Experiment 1.

| ID      | Condition     | F to F | Ambiguous | Not paying attention |
|---------|---------------|--------|-----------|----------------------|
| mouse17 | Unlearning    | 0%     | 15%       | 85%                  |
| mouse18 | Unlearning    | 5%     | 20%       | 75%                  |
| mouse19 | Unlearning    | 5%     | 15%       | 80%                  |
| mouse20 | Unlearning    | 10%    | 25%       | 65%                  |
| mouse21 | Unlearning    | 5%     | 40%       | 55%                  |
| mouse22 | Unlearning    | 10%    | 10%       | 80%                  |
| mouse23 | Unlearning    | 5%     | 30%       | 65%                  |
| mouse24 | Unlearning    | 5%     | 40%       | 55%                  |
| mouse25 | Unlearning    | 5%     | 30%       | 65%                  |
| mouse26 | Unlearning    | 20%    | 45%       | 35%                  |
| mouse27 | Unlearning    | 15%    | 40%       | 45%                  |
| mouse28 | Unlearning    | 10%    | 25%       | 65%                  |
| mouse29 | Unlearning    | 15%    | 40%       | 45%                  |
| mouse30 | Unlearning    | 5%     | 40%       | 55%                  |
| mouse31 | Unlearning    | 10%    | 50%       | 40%                  |
| mouse32 | Unlearning    | 10%    | 30%       | 60%                  |

Table 7 (Individual data) and Fig. 5 (Averaging data) show the total experimental time in Experiment 1. The total training time for each individual in training sessions 1–7 and the average total training time were calculated to determine if there was a difference in training time between the Learning and Unlearning groups. The total training time between the Learning and Unlearning groups was significantly different (t(15) = 15.23, p < 0.01). The time spent in the apparatus was longer for the Learning group. Fig. 6 shows the correlation between the average total training time and the frequency of “face to face” behavior. There was no correlation between training time and the occurrence of “face to face” behavior in the test sessions of Experiments 1 and 2 (Ex1: r = -0.18, p = 0.52, n.s.; Ex2: r = -0.13, p = 0.72, n.s.).

In Experiment 2, after training the mice to perform reaching behavior as done in Experiment 1, data on searching for other individuals performing reaching behavior, searching for untrained individuals, and searching for empty boxes were collected.

Table 8 provides the characteristics of the observer mice and their assigned conditions (a condition in which the demonstrator to be observed has learned or not learned reaching behavior or a condition in which an empty box is present) in the test session of Experiment 2. Table 9 shows the characteristics of the mice (Learning or Unlearning group) used as demonstrators in the test session.
### Table 6
Occurrence rate of the observer’s position being close to the slit in Experiment 1.

| ID   | Condition  | Rate of the observer’s position close to slit |
|------|------------|---------------------------------------------|
| mouse1 | Learning   | 55.44%                                      |
| mouse2 | Learning   | 41.22%                                      |
| mouse3 | Learning   | 68.34%                                      |
| mouse4 | Learning   | 62.83%                                      |
| mouse5 | Learning   | 69.96%                                      |
| mouse6 | Learning   | 45.32%                                      |
| mouse7 | Learning   | 77.50%                                      |
| mouse8 | Learning   | 56.90%                                      |
| mouse9 | Learning   | 59.21%                                      |
| mouse10 | Learning  | 40.04%                                      |
| mouse11 | Learning  | 48.48%                                      |
| mouse12 | Learning  | 63.22%                                      |
| mouse13 | Learning  | 68.45%                                      |
| mouse14 | Learning  | 68.20%                                      |
| mouse15 | Learning  | 51.65%                                      |
| mouse16 | Learning  | 52.72%                                      |
| mouse17 | Unlearning | 36.51%                                      |
| mouse18 | Unlearning | 61.75%                                      |
| mouse19 | Unlearning | 23.86%                                      |
| mouse20 | Unlearning | 37.88%                                      |
| mouse21 | Unlearning | 41.42%                                      |
| mouse22 | Unlearning | 45.63%                                      |
| mouse23 | Unlearning | 31.77%                                      |
| mouse24 | Unlearning | 47.21%                                      |
| mouse25 | Unlearning | 54.27%                                      |
| mouse26 | Unlearning | 59.17%                                      |
| mouse27 | Unlearning | 55.16%                                      |
| mouse28 | Unlearning | 42.37%                                      |
| mouse29 | Unlearning | 52.76%                                      |
| mouse30 | Unlearning | 65.52%                                      |
| mouse31 | Unlearning | 53.32%                                      |
| mouse32 | Unlearning | 65.84%                                      |

**Fig. 4.** The occurrence rate of the observer’s position being close to the slit in the observation room during the test session in Experiment 1. The rate of the observer’s position being close to the slit was significantly higher in the Learning group than that in the Unlearning group. Error bars represent the standard error of the mean. *p < 0.05.
Table 7
Total time duration of learning sessions and test sessions. The Unlearning group spent 600 s in each training session, from session 1 to session 7.

| ID   | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 | Session 7 | Test 1 | Test 2 |
|------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|--------|--------|
| mouse1 | 1200      | 1200      | 1200      | 923       | 788       | 881       | 572       | 558    | 578    |
| mouse2 | 1200      | 1200      | 1200      | 856       | 659       | 671       | 491       | 495    | 502    |
| mouse3 | 1200      | 1200      | 1063      | 963       | 813       | 788       | 704       | 696    | 704    |
| mouse4 | 1200      | 1200      | 1032      | 700       | 672       | 558       | 623       | 605    | 623    |
| mouse5 | 1200      | 1200      | 1023      | 922       | 572       | 608       | 656       | 608    | 618    |
| mouse6 | 1200      | 1200      | 1124      | 820       | 710       | 553       | 693       | 553    | 607    |
| mouse7 | 1200      | 1200      | 1155      | 818       | 643       | 569       | 563       | 569    | 598    |
| mouse8 | 1200      | 1200      | 1032      | 883       | 667       | 536       | 527       | 536    | 538    |
| mouse9 | 1200      | 1200      | 1200      | 877       | 574       | 382       | 362       | 433    | 412    |
| mouse10 | 1200     | 1200      | 911       | 498       | 464       | 373       | 341       | 409    | 412    |
| mouse11 | 1200     | 1200      | 1058      | 834       | 627       | 568       | 520       | 640    | 515    |
| mouse12 | 1200     | 1200      | 1200      | 552       | 592       | 334       | 350       | 465    | 459    |
| mouse13 | 1200     | 1050      | 1200      | 599       | 378       | 533       | 476       | 453    | 429    |
| mouse14 | 1200     | 1200      | 1141      | 803       | 671       | 487       | 473       | 493    | 537    |
| mouse15 | 1200     | 1200      | 1132      | 678       | 586       | 448       | 425       | 437    | 427    |
| mouse16 | 1200     | 1200      | 1155      | 596       | 588       | 465       | 517       | 486    | 416    |

Fig. 5. The total experiment time in the training session in Experiment 1. In the Learning group, the mice were trained in reaching behavior via 20 trials in a session twice a day in the reaching room. The time limit of each session was 20 min. In the Unlearning group, the mice were put in the observation room for 10 min without pasta while keeping the reaching room empty during each session. Error bars represent standard error of the mean.

Table 10 shows the observer's position information, which was calculated in the same way as that used for the information in Table 6. Table 11 shows the success rate of reaching for each mouse in the training sessions 3 to 7 in Experiment 2; it is similar to Table 2 for Experiment 1. Table 12 shows the spinning time in session 7 and in the test session with only Learning-Learning pairs. Table 13 shows the behavior of the observer at the time when the other mouse was reaching during the test session in Experiment 2, similar to that shown in Tables 4 and 5. Table 14 shows the total experimental time in Experiment 2, similar to that in Table 7. These data (Tables 11–14) allow us to confirm whether the mice learned reaching equally in both Experiment 1 and Experiment 2.

The raw data for Fig. 4-6 and Tables 2-7, 10-14 are created from the "RawData.xlsx" of the supplemental material. The experimental videos that are the source of the manually coded data (Fig. 2-3) have been uploaded to the Zenodo repository.
Table 8
The characteristics of mice used as observers in Experiment 2.

| ID     | Week | Age | Weight at the start (g) | Cage | Learning or Unlearning | Condition   | Test partner | Weight at the end (g) |
|--------|------|-----|-------------------------|------|------------------------|-------------|--------------|----------------------|
| ex2_mouse1 | 7    | 19  | 19                      | Cage1 | Learning               | Learning    | mouse7       | 19.6                 |
| ex2_mouse2 | 7    | 18.3| 19                      | Cage1 | Learning               | Learning    | mouse8       | 18.8                 |
| ex2_mouse3 | 7    | 18.4| 18.4                    | Cage1 | Learning               | Unlearning  | mouse9       | 18.8                 |
| ex2_mouse4 | 7    | 18.4| 18.4                    | Cage1 | Learning               | Unlearning  | mouse10      | 18.4                 |
| ex2_mouse5 | 7    | 17.5| 18.4                    | Cage2 | Learning               | Empty       |             | 18.5                 |
| ex2_mouse6 | 7    | 20.2| 20.2                    | Cage2 | Learning               | Empty       |             | 20.2                 |
| ex2_mouse11 | 6   | 19.3| 19.3                    | Cage4 | Learning               | Learning    | mouse17      | 19.6                 |
| ex2_mouse12 | 6   | 19.2| 19.2                    | Cage4 | Learning               | Learning    | mouse18      | 19.3                 |
| ex2_mouse13 | 6   | 18.6| 18.6                    | Cage4 | Learning               | Unlearning  | mouse19      | 18.7                 |
| ex2_mouse14 | 6   | 19.3| 19.3                    | Cage4 | Learning               | Unlearning  | mouse20      | 19.1                 |
| ex2_mouse15 | 6   | 19.1| 19.1                    | Cage5 | Learning               | Empty       |             | 18.5                 |
| ex2_mouse16 | 6   | 18.7| 18.7                    | Cage5 | Learning               | Empty       |             | 18.8                 |
| ex2_mouse21 | 5   | 21.2| 21.2                    | Cage7 | Learning               | Learning    | mouse27      | 19.8                 |
| ex2_mouse22 | 5   | 20.1| 20.1                    | Cage7 | Learning               | Learning    | mouse28      | 20.4                 |
| ex2_mouse23 | 5   | 20.9| 20.9                    | Cage7 | Learning               | Unlearning  | mouse29      | 20.1                 |
| ex2_mouse24 | 5   | 19.9| 19.9                    | Cage7 | Learning               | Unlearning  | mouse30      | 18.9                 |
| ex2_mouse25 | 5   | 21.5| 21.5                    | Cage8 | Learning               | Empty       |             | 20.7                 |
| ex2_mouse26 | 5   | 20.8| 20.8                    | Cage8 | Learning               | Empty       |             | 20.1                 |
| ex2_mouse31 | 6   | 20.6| 20.6                    | Cage10 | Learning            | Learning    | mouse37      | 19.6                |
| ex2_mouse32 | 6   | 20.7| 20.7                    | Cage10 | Learning            | Learning    | mouse38      | 19.9                 |
| ex2_mouse33 | 6   | 21.6| 21.6                    | Cage10 | Learning            | Unlearning  | mouse39      | 20.9                 |
| ex2_mouse34 | 6   | 22.3| 22.3                    | Cage10 | Learning            | Unlearning  | mouse40      | 20.7                 |
| ex2_mouse35 | 6   | 20.2| 20.2                    | Cage11 | Learning          | Empty       |             | 19.9                 |
| ex2_mouse36 | 6   | 20.3| 20.3                    | Cage11 | Learning          | Empty       |             | 19.5                 |
| ex2_mouse41 | 6   | 18.8| 18.8                    | Cage13 | Learning          | Learning    | mouse47      | 18.7                 |
| ex2_mouse42 | 6   | 17.8| 17.8                    | Cage13 | Learning          | Learning    | mouse48      | 18.3                 |
| ex2_mouse43 | 6   | 21  | 21                      | Cage13 | Learning          | Unlearning  | mouse49      | 19.4                 |
| ex2_mouse44 | 6   | 19.3| 19.3                    | Cage13 | Learning          | Unlearning  | mouse50      | 18.4                 |
| ex2_mouse45 | 6   | 20.6| 20.6                    | Cage14 | Learning          | Empty       |             | 19.3                 |
| ex2_mouse46 | 6   | 19.9| 19.9                    | Cage14 | Learning          | Empty       |             | 18.7                 |
Table 9
The characteristics of mice used as demonstrators in the test session in Experiment 2.

| ID          | Week | age | Weight at the start (g) | Cage | Learning or Unlearning | Test partner | Weight at the end (g) |
|-------------|------|-----|-------------------------|------|------------------------|--------------|----------------------|
| ex2_mouse7  | 7    | 21.3| Cage2                   | Learning | mouse1         | Non-cage mate | 21.8           |
| ex2_mouse8  | 7    | 19  | Cage2                   | Learning | mouse2       | Non-cage mate | 19.5           |
| ex2_mouse9  | 7    | 18.5| Cage3                   | Learning | mouse3      | Non-cage mate | 19.1           |
| ex2_mouse10 | 7    | 17.8| Cage3                   | Unlearning | mouse4    | Non-cage mate | 18.4           |
| ex2_mouse17 | 6    | 20.1| Cage5                   | Learning | mouse11     | Non-cage mate | 19.8           |
| ex2_mouse18 | 6    | 19.2| Cage5                   | Learning | mouse12     | Non-cage mate | 18.9           |
| ex2_mouse19 | 6    | 18.9| Cage6                   | Unlearning | mouse13  | Non-cage mate | 18.5           |
| ex2_mouse20 | 6    | 18.9| Cage6                   | Unlearning | mouse14  | Non-cage mate | 18.7           |
| ex2_mouse27 | 5    | 19.6| Cage8                   | Learning | mouse21     | Non-cage mate | 19.4           |
| ex2_mouse28 | 5    | 18.4| Cage8                   | Learning | mouse22     | Non-cage mate | 17.3           |
| ex2_mouse29 | 5    | 18.3| Cage9                   | Unlearning | mouse23 | Non-cage mate | 18             |
| ex2_mouse30 | 5    | 17.4| Cage9                   | Unlearning | mouse24 | Non-cage mate | 17             |
| ex2_mouse37 | 6    | 19.8| Cage11                  | Learning | mouse31     | Non-cage mate | 18.9           |
| ex2_mouse38 | 6    | 22.1| Cage11                  | Learning | mouse32     | Non-cage mate | 21.1           |
| ex2_mouse39 | 6    | 22.2| Cage12                  | Unlearning | mouse33 | Non-cage mate | 21.2           |
| ex2_mouse40 | 6    | 22.1| Cage12                  | Unlearning | mouse34 | Non-cage mate | 20.7           |
| ex2_mouse47 | 6    | 19.5| Cage14                  | Learning | mouse41     | Non-cage mate | 18.3           |
| ex2_mouse48 | 6    | 20.9| Cage14                  | Learning | mouse42     | Non-cage mate | 19.3           |
| ex2_mouse49 | 6    | 20.9| Cage15                  | Unlearning | mouse43 | Non-cage mate | 18.8           |
| ex2_mouse50 | 6    | 23.4| Cage15                  | Unlearning | mouse44 | Non-cage mate | 21.8           |

Table 10
The occurrence rate of the observer’s position being close to the slit in Experiment 2.

| ID          | Condition | Rate of the observer’s position close to slit |
|-------------|-----------|---------------------------------------------|
| ex2_mouse1  | Learning  | 64.09%                                       |
| ex2_mouse2  | Learning  | 49.69%                                       |
| ex2_mouse3  | Unlearning| 39.47%                                       |
| ex2_mouse4  | Unlearning| 59.20%                                       |
| ex2_mouse5  | Empty     | 51.41%                                       |
| ex2_mouse6  | Empty     | 51.74%                                       |
| ex2_mouse11 | Learning  | 58.68%                                       |
| ex2_mouse12 | Learning  | 78.91%                                       |
| ex2_mouse13 | Unlearning| 53.07%                                       |
| ex2_mouse14 | Unlearning| 38.31%                                       |
| ex2_mouse15 | Empty     | 51.08%                                       |
| ex2_mouse16 | Empty     | 51.58%                                       |
| ex2_mouse21 | Learning  | 73.41%                                       |
| ex2_mouse22 | Learning  | 63.55%                                       |
| ex2_mouse23 | Unlearning| 46.10%                                       |
| ex2_mouse24 | Unlearning| 52.24%                                       |
| ex2_mouse25 | Empty     | 51.58%                                       |
| ex2_mouse26 | Empty     | 44.44%                                       |
| ex2_mouse31 | Learning  | 69.22%                                       |
| ex2_mouse32 | Learning  | 55.12%                                       |
| ex2_mouse33 | Unlearning| 52.07%                                       |
| ex2_mouse34 | Unlearning| 47.10%                                       |
| ex2_mouse35 | Empty     | 48.26%                                       |
| ex2_mouse36 | Empty     | 42.79%                                       |
| ex2_mouse41 | Learning  | 53.96%                                       |
| ex2_mouse42 | Learning  | 69.44%                                       |
| ex2_mouse43 | Unlearning| 56.88%                                       |
| ex2_mouse44 | Unlearning| 57.05%                                       |
| ex2_mouse45 | Empty     | 53.90%                                       |
| ex2_mouse46 | Empty     | 43.62%                                       |
Fig. 6. The relationship between training time and occurrence of “face to face” behavior. The occurrence rate was calculated by dividing the number of times “face to face” behavior was noted by the total number of trials, which was 20. The average of total training time was calculated from session 1 to session 7 for each mouse. Ex1: Experiment 1, Ex2: Experiment 2, learning: learning observer.

2. Experimental Design, Materials, and Methods

2.1. Design Experiment 1

The purpose of Experiment 1 was to determine whether mice observe the behavior of other individuals based on their learning experience [1]. Thirty-two C57BL/N male mice were prepared and randomly assigned to the Learning and Unlearning groups (Fig. 1). The Learning group was trained in reaching behavior in the reaching room, and the Unlearning group was habituated in the observation room. After the training, the main data collection was conducted in test sessions.

In the test session, we categorized the mice in the observation room and reaching room as cage mates or non-cage mates (Fig. 1; Table 1), and the occurrence of the three categories of behavior, “face to face,” “ambiguous,” and “not paying attention,” was calculated (Fig. 2 and Fig. 3). In summary, Experiment 1 was conducted using a two-factor between-subjects design (2 [learning/unlearning] × 2 [cage mate/non-cage mate]).

We measured the time required by a mouse to complete a single spin before performing the reaching action in the test session to assess social perception. In animals, it is known that trained behavior is facilitated by social perception [1,2]. Then, we compared the speed of spin in reaching individuals for the following conditions: absence of observers (session 7), presence of an unlearning observer, or presence of a learning observer (Table 3).

The time mice spent close to the slit in the observation room during the test session was then calculated from the video captured by the upper camera to determine if there was a difference in rate of the observer position between the Learning and Unlearning groups in the total time in the test session (Fig. 4; Table 6).

2.2. Design Experiment 2

The purpose of Experiment 2 was to evaluate which of the following factors influence the motivation of mice to observe the behavior of other individuals in Experiment 1: the movement
intention of other individuals or the situation of the presence of other individuals, and the food table. Thirty male C57BL/N mice were prepared and randomly assigned to the Learning, Unlearning, and Empty groups, with ten animals in each group (Table 8). After three groups were trained to reach for food in the same way, the situations assigned to them in the test session were different as follows. The Learning group observed the reaching behavior of other individuals. The Unlearning group was placed in a situation where unlearned individuals were present in the training room. The Empty group was placed as the situation where the training room was empty.

Twenty animals were prepared for the demonstration of learned reaching or unlearned reaching in the reaching room in the test session (Table 9).

Forty animals (30 in three experimental groups; ten demonstrators for the test session) were trained in reaching behavior. Ten demonstrators of unlearned reaching were habituated as done in Experiment 1. After the training, the main data collection was conducted in a test session.

In the test sessions, the time mice spent close to the slit in the observation room was measured using the videos from the upper camera, and the rate of the observer position being close

| ID         | Session 3 | Session 4 | Session 5 | Session 6 | Session 7 |
|------------|-----------|-----------|-----------|-----------|-----------|
| ex2_mouse1 | 0%        | 0%        | 35%       | 80%       | 70%       |
| ex2_mouse2 | 0%        | 0%        | 20%       | 55%       | 75%       |
| ex2_mouse3 | 0%        | 5%        | 25%       | 45%       | 65%       |
| ex2_mouse4 | 0%        | 0%        | 5%        | 50%       | 70%       |
| ex2_mouse5 | 5%        | 20%       | 50%       | 80%       | 80%       |
| ex2_mouse6 | 0%        | 50%       | 45%       | 15%       | 70%       |
| ex2_mouse7 | 0%        | 25%       | 50%       | 50%       | 80%       |
| ex2_mouse8 | 0%        | 0%        | 5%        | 50%       | 70%       |
| ex2_mouse9 | 0%        | 0%        | 60%       | 40%       | 65%       |
| ex2_mouse10| 0%        | 0%        | 50%       | 40%       | 65%       |
| ex2_mouse11| 0%        | 0%        | 60%       | 40%       | 65%       |
| ex2_mouse12| 0%        | 0%        | 50%       | 40%       | 65%       |
| ex2_mouse13| 0%        | 15%       | 30%       | 30%       | 65%       |
| ex2_mouse14| 30%       | 15%       | 45%       | 55%       | 75%       |
| ex2_mouse15| 35%       | 55%       | 65%       | 75%       | 70%       |
| ex2_mouse16| 30%       | 40%       | 35%       | 35%       | 65%       |
| ex2_mouse17| 60%       | 65%       | 50%       | 50%       | 75%       |
| ex2_mouse18| 40%       | 40%       | 55%       | 45%       | 65%       |
| ex2_mouse19| 25%       | 65%       | 15%       | 55%       | 65%       |
| ex2_mouse20| 25%       | 35%       | 65%       | 65%       | 70%       |
| ex2_mouse21| 50%       | 70%       | 85%       | 50%       | 70%       |
| ex2_mouse22| 40%       | 45%       | 50%       | 45%       | 70%       |
| ex2_mouse23| 40%       | 80%       | 80%       | 80%       | 80%       |
| ex2_mouse24| 30%       | 75%       | 50%       | 40%       | 80%       |
| ex2_mouse25| 40%       | 50%       | 55%       | 55%       | 70%       |
| ex2_mouse26| 45%       | 55%       | 55%       | 70%       | 75%       |
| ex2_mouse27| 0%        | 50%       | 35%       | 25%       | 65%       |
| ex2_mouse28| 0%        | 70%       | 75%       | 60%       | 80%       |
| ex2_mouse29| 15%       | 35%       | 60%       | 40%       | 65%       |
| ex2_mouse30| 0%        | 35%       | 55%       | 50%       | 65%       |
| ex2_mouse31| 0%        | 30%       | 60%       | 70%       | 70%       |
| ex2_mouse32| 20%       | 55%       | 70%       | 70%       | 65%       |
| ex2_mouse33| 0%        | 0%        | 80%       | 40%       | 65%       |
| ex2_mouse34| 0%        | 5%        | 55%       | 80%       | 80%       |
| ex2_mouse35| 15%       | 50%       | 15%       | 20%       | 70%       |
| ex2_mouse36| 15%       | 65%       | 35%       | 65%       | 85%       |
| ex2_mouse37| 35%       | 35%       | 55%       | 65%       | 65%       |
| ex2_mouse38| 0%        | 35%       | 35%       | 30%       | 65%       |
| ex2_mouse39| 25%       | 40%       | 60%       | 50%       | 70%       |
| ex2_mouse40| 10%       | 30%       | 45%       | 90%       | 75%       |
| ex2_mouse41| 0%        | 30%       | 5%        | 80%       | 75%       |
| ex2_mouse42| 10%       | 30%       | 45%       | 65%       | 75%       |
Table 12
Speed of spinning in Experiment 2 (in the test session, only learning-learning pair).

| ID           | Condition  | Session 7 | Test |
|--------------|------------|-----------|------|
| ex2_mouse1   | Learning   | 1.95      |      |
| ex2_mouse2   | Learning   | 1.94      |      |
| ex2_mouse3   | Unlearning | 2.58      |      |
| ex2_mouse4   | Unlearning | 1.99      |      |
| ex2_mouse5   | Empty      | 1.25      |      |
| ex2_mouse6   | Empty      | 2.04      |      |
| ex2_mouse7   |            | 2.03      | 1.11 |
| ex2_mouse8   |            | 2.51      | 1.14 |
| ex2_mouse11  | Learning   | 1.69      |      |
| ex2_mouse12  | Learning   | 1.69      |      |
| ex2_mouse13  | Unlearning | 2.18      |      |
| ex2_mouse14  | Unlearning | 1.83      |      |
| ex2_mouse15  | Empty      | 1.47      |      |
| ex2_mouse16  | Empty      | 1.26      |      |
| ex2_mouse17  |            | 1.74      | 1.31 |
| ex2_mouse18  |            | 1.70      | 1.42 |
| ex2_mouse21  | Learning   | 1.97      |      |
| ex2_mouse22  | Learning   | 1.56      |      |
| ex2_mouse23  | Unlearning | 1.25      |      |
| ex2_mouse24  | Unlearning | 1.28      |      |
| ex2_mouse25  | Empty      | 2.02      |      |
| ex2_mouse26  | Empty      | 1.46      |      |
| ex2_mouse27  |            | 1.85      | 1.05 |
| ex2_mouse28  |            | 1.36      | 1.02 |
| ex2_mouse31  | Learning   | 1.63      |      |
| ex2_mouse32  | Learning   | 1.54      |      |
| ex2_mouse33  | Unlearning | 1.32      |      |
| ex2_mouse34  | Unlearning | 1.99      |      |
| ex2_mouse35  | Empty      | 1.35      |      |
| ex2_mouse36  | Empty      | 1.20      |      |
| ex2_mouse37  |            | 1.51      | 1.21 |
| ex2_mouse38  |            | 1.33      | 1.03 |
| ex2_mouse41  | Learning   | 1.45      |      |
| ex2_mouse42  | Learning   | 1.31      |      |
| ex2_mouse43  | Unlearning | 1.34      |      |
| ex2_mouse44  | Unlearning | 1.20      |      |
| ex2_mouse45  | Empty      | 1.31      |      |
| ex2_mouse46  | Empty      | 1.37      |      |
| ex2_mouse47  |            | 1.20      | 1.09 |
| ex2_mouse48  |            | 1.32      | 1.28 |

Table 13
Frequency of behavioral categories of learning-learning pair in Experiment 2.

| ID           | F to F  | Ambiguous | Not paying attention |
|--------------|---------|-----------|----------------------|
| ex2_mouse1   | 45%     | 30%       | 25%                  |
| ex2_mouse2   | 45%     | 25%       | 30%                  |
| ex2_mouse11  | 40%     | 25%       | 35%                  |
| ex2_mouse12  | 45%     | 30%       | 25%                  |
| ex2_mouse21  | 40%     | 25%       | 35%                  |
| ex2_mouse22  | 45%     | 30%       | 25%                  |
| ex2_mouse31  | 45%     | 30%       | 25%                  |
| ex2_mouse32  | 30%     | 35%       | 35%                  |
| ex2_mouse41  | 25%     | 35%       | 40%                  |
| ex2_mouse42  | 40%     | 35%       | 25%                  |
Table 14
Total time duration of learning sessions and test session in Experiment 2.

| ID    | Condition | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 | Session 7 | Test |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------|
| ex2_mouse1 | Learning | 1200 | 1200 | 1200 | 1200 | 1109 | 768 | 555 | 401 |
| ex2_mouse2 | Learning | 1200 | 1200 | 1200 | 1200 | 898 | 560 | 733 | 650 |
| ex2_mouse3 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1091 | 1057 | 1191 | 603 |
| ex2_mouse4 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 755 | 603 |
| ex2_mouse5 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 571 | 603 |
| ex2_mouse6 | Empty | 1200 | 1200 | 1200 | 1200 | 815 | 770 | 502 | 603 |
| ex2_mouse7 | Learning | 1200 | 1200 | 1200 | 1200 | 1200 | 1037 | 907 | 605 |
| ex2_mouse8 | Learning | 1200 | 1200 | 1200 | 1200 | 764 | 760 | 578 | 697 |
| ex2_mouse9 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 1181 | 603 |
| ex2_mouse10 | Unlearning | 1200 | 1200 | 1200 | 1200 | 976 | 788 | 1189 | 603 |
| ex2_mouse11 | Empty | 1200 | 1200 | 1200 | 738 | 651 | 573 | 381 | 603 |
| ex2_mouse12 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1159 | 908 | 843 | 603 |
| ex2_mouse13 | Learning | 1200 | 1200 | 1200 | 1200 | 933 | 599 | 622 | 640 |
| ex2_mouse14 | Learning | 1200 | 1200 | 1200 | 1200 | 1200 | 838 | 776 | 524 |
| ex2_mouse15 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1011 | 774 | 424 | 460 |
| ex2_mouse16 | Unlearning | 1200 | 1200 | 1200 | 1200 | 974 | 711 | 736 | 617 |
| ex2_mouse17 | Empty | 1200 | 1200 | 802 | 1200 | 497 | 534 | 412 | 603 |
| ex2_mouse18 | Empty | 1200 | 1200 | 1200 | 895 | 429 | 376 | 478 | 603 |
| ex2_mouse19 | Learning | 1200 | 1200 | 1200 | 1200 | 808 | 890 | 754 | 536 |
| ex2_mouse20 | Learning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 715 | 603 |
| ex2_mouse21 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 715 | 603 |
| ex2_mouse22 | Unlearning | 1200 | 1200 | 1200 | 1200 | 1041 | 775 | 619 | 603 |
| ex2_mouse23 | Unlearning | 1200 | 1200 | 1200 | 1200 | 401 | 595 | 1195 | 603 |
| ex2_mouse24 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1159 | 581 | 603 |
| ex2_mouse25 | Empty | 1200 | 1200 | 1200 | 1200 | 802 | 920 | 648 | 1079 |
| ex2_mouse26 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 600 | 603 |
| ex2_mouse27 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse28 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse29 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse30 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse31 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse32 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse33 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse34 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse35 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse36 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse37 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse38 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse39 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse40 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse41 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse42 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse43 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse44 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse45 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse46 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse47 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse48 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse49 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |
| ex2_mouse50 | Empty | 1200 | 1200 | 1200 | 1200 | 1200 | 1200 | 600 | 603 |

to the slit for each total time in the test was determined. We compared the values obtained in the three conditions, learning, unlearning, and empty (Table 10). Thus, Experiment 2 had a one-factor, three-level (learning, unlearning, and empty), between-subjects design. We also categorized the occurrence of the three categories (face to face, ambiguous, and not paying attention) in the learning-learning pair, as in Experiment 1 (Fig. 2 and Fig. 3).
2.3. Materials

2.3.1. Animals in Experiments 1 and 2

For Experiment 1, 32 male C57BL/N mice (CREA Japan Inc.), with a mean weight of 21.25 g (SD: 1.12 g) and an age of 6 weeks at the time of purchase, were separated into groups of four mice and housed in a temperature-controlled (approximately 23 °C) animal room under a 12 h light/dark cycle (light from 8:00 AM to 20:00 PM) (Table 1). Before the experiments, the mice were provided with food (CE-2, CREA Japan, Inc.) and tap water ad libitum as preliminary breeding for one week. During the behavioral experiments, approximately 1 g of food per day was provided to each mouse after the day’s experiment. Tap water was continuously available in their home cages.

For Experiment 2, 50 male C57BL/N mice (CREA Japan Inc.), with a mean weight of 19.25 g (SD: 1.39 g) and an age of 5–7 weeks at the time of purchase, were separated into groups of two or four mice (Table 8 and Table 9). We randomly assigned ten animals to the Learning group, ten to the Unlearning group, and ten to the Empty group. They were all trained in reaching. In addition, twenty animals were prepared as demonstrators of learned reaching or unlearned reaching in the reaching room for the test session. The demonstrators for the unlearned reaching group only exhibited the unlearned reaching behavior in the test session. Before the experiments, the treatment during preliminary breeding was the same as that in Experiment 1, except that the duration was 1–14 days. During the experiment, the feeding and water restriction schedule was the same as that in Experiment 1.

2.3.2. Apparatus in Experiments 1 and 2

The apparatus included a reaching room and an observation room [1]. Both compartments were 10 cm deep, 19 cm wide, and 20 cm tall and were made of transparent acrylic with a feeding table between the two sides. In the reaching room, a slit (10 mm) was created near the feeding table to allow the mice to reach for and grasp a piece of pasta. In the observation room, a slit (1 mm) was created towards the feeding table. The design of the reaching room was according to that described by Farr and Wishaw (2002) [3]. Using a stick that could hold pasta, the experimenter would bring the pasta in front of the slits. We placed two video cameras, one above and another in front of the apparatus, and recorded the animals’ behaviors (60 fps).

2.4. Methods

2.4.1. Training in Experiments 1 and 2

The Learning group was trained in reaching behavior twice daily in the reaching room. Reaching behavior was defined as reaching for a food reward (pasta), grasping, and eating it [4]. In a session, twenty rewards (20 trials) were provided to a mouse to allow it to accurately perform the act of reaching for and grasping the pasta; there was a time limit of 20 min for each session. Approximately 1–2 days before the first training, the mice were given pasta and habituated with it. The pasta was cut into a length of approximately 2–3 mm, and each piece weighed 10 mg. The inter-trial interval in a session depended on individual mouse behavior.

In sessions 1 and 2, the mice were trained to reach for and grasp the pasta with their forepaws. From session 3 or 4, the experimenter did not present pasta when the mouse was sitting in front of the slit but presented it when the mouse was positioned away from the slit. This caused the mouse to turn in its spot before reaching for the pasta. Therefore, the mouse does not perform the reaching movement in the absence of the trigger but does so in its presence. Additionally, the movement before reaching could be standardized. In sessions 5–7, we trained the mice to reach for and grasp the pasta only after they had performed the spinning movement.

The mice from the Unlearning group in Experiment 1 and demonstrators for the Unlearning group in Experiment 2 were placed in the observation room for 10 min without pasta while keeping the reaching room empty during each session.
A reaching success rate of over 60% was the criterion for completion of learning. Mice that exceeded this criterion were then subjected to test sessions.

2.4.2. Test session in Experiment 1
Following session 7 of Experiment 1, we immediately conducted an observation test; in this, we determined if mice in the observation room paid attention to the other mice performing reaching behavior and compared the amount of time mice spent close to the slit the reaching room between the Learning and Unlearning groups (Tables 4 and 5). The next day of the test session, the pairs were changed. For Experiment 1, 16 cage mate and 16 non-cage mate pairs of observers and reaching mice were created. Furthermore, the reaching mice were observed once by both the Learning and the Unlearning groups. The combinations of the pairs are shown in Fig. 1 and Table 1.

For the observation test, we manually classified the behavior of the observer during reaching situations into three different categories using a previous study as a reference [1, 2]: “face to face,” “ambiguous,” and “not paying attention” (Fig. 2 and Fig. 3).

We measured the time required to complete a single spin before performing the reaching action in session 7 for the Learning group and the Unlearning group (Table 3). The starting point of the spin was the first frame in the video in which the mouse started spinning after sitting in front of the slit, and the end point was the frame before the one in which the front paws of the mice were away from the ground. We measured the time with a stopwatch.

The time spent close to the slit by the mice in the observation room during the test session was then calculated from the videos of the upper camera using the stopwatch (Fig. 4; Table 6). The observation room was divided into two regions, one on the side of the slit and the other on the opposite side of the slit, to determine if there was a difference in the time spent by the observing individuals in each region. The rate of the observer position was close to the slit was calculated by dividing the time spent near the slit by the total time of the experiment.

2.4.3. Test session in Experiment 2
Following session 7 of Experiment 2, an observation test was conducted, which was similar to that in Experiment 1, except for the conditions. We examined whether the mice that have learned reaching behavior in the observation room spent time close to the slit under three conditions as follows: learning or unlearning mice in the reaching room or empty reaching room (Table 10). We calculated the occurrence rate of the observer’s position being close to the slit based on the total time of the test session.

In addition, we measured the time of a single spin in only the learning-learning pair (Table 12) and manually classified the reaching situations into three categories; Face to face, ambiguous, and Not paying attention (Table 13), as in Experiment 1.

Ethics Statement

All experiments involving animals were performed following the guidelines for animal research at Tohoku University. The experimental protocols were approved by the Ethical Review Board for Animal Study of the Tohoku University School of Medicine (No. 2017–334).

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that have, or could be perceived to have, influenced the work reported in this article.

Acknowledgments

This work was supported by the Visionary Research Grant 2016 of the Takeda Science Foundation and JSPS KAKENHI Grant Number JP20H01780.
Supplementary Materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.dib.2021.106773.

References

[1] M. Ukezono, Y. Takano, An experimental task to examine the mirror neuron system in mice: laboratory mice understand the movement intentions of other individuals through their own experience, Behav. Brain Res. 33 (2020) In press, doi:10.1016/j.bbr.2020.127970.

[2] Y. Takano, M. Ukezono, An experimental task to examine the mirror system in rats, Sci. Rep. 4 (2014) 6652, doi:10.1038/srep06652.

[3] T.D. Farr, I.Q. Whishaw, Quantitative and qualitative impairments in skilled reaching in the mouse (Mus musculus) after a focal motor cortex stroke, Stroke 33 (7) (2002) 1869–1875, doi:10.1161/01.str.0000020714.48349.4e.

[4] I.Q. Whishaw, J. Faraji, J. Kuntz, B. Mirza Agha, M. Patel, G. Metz, M.H. Mohajerani, Organization of the reach and grasp in head-fixed vs freely-moving mice provides support for multiple motor channel theory of neocortical organization, Exp. Brain Res. 235 (6) (2017) 1919–1932, doi:10.1007/s00221-017-4925-4.