**Appendix**

**Supplementary information: Statistical tests**

Inter-group comparisons were made by two-way analysis of variance (ANOVA) with repeated measures based on type III sums of squares. Degrees of freedom (*DF*s) were adjusted for non–sphericity using the Greenhouse–Geisser correction. Note that we did not perform any test for sphericity, as we tried to avoid multiple statistical tests. *F* scores and corresponding *P* values were calculated based on the adjusted *DF*s. Post-hoc pairwise comparisons were made after a Holm’s correction with the significance level set at *P* = 0.05.

Statistical calculations were performed using R (version 3.1.3, Windows version) and the “ANOVAKUN 4.8.0” add-on (programmed by Dr. Ryuta Iseki, <http://riseki.php.xdomain.jp/index.php?ANOVA%E5%90%9B>).

In this experiment, we focused on the running distance (Fig.2a) and the patch-use ratio as response variables (Fig.2b–e). *Group* is a between-individual variable, which denotes the foraging condition in the I-shaped maze (i.e. single, pair, or mirror). *Day* is a within-individual variable, which denotes the post-hatch day when the behaviours were recorded.

1. **Running distance during feeding** **(Fig****. 2a)**

**1.1. Pre-reversal data (Day 8–11)**

Table 1.1.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)= 11.3572 | *p*= 0.0001 \*\*\* |
| *Day* | F(2.77, 158.07)=93.2664 | *p*< 0.0001 \*\*\* |
| *Interaction (group : day)* | F(5.55, 158.07)= 9.0098 | *p*< 0.0001 \*\*\* |

Table 1.1.2: Post-hoc pairwise comparisons

|  |  |  |
| --- | --- | --- |
| Single : Pair | *t*=4.1020 | *p*=0.0003 \*\*\* |
| Single :Mirror | *t*=4.2434 | *p*=0.0002 \*\*\* |
| Pair : Mirror | *t*=0.4344 | *p*=0.6657  |

Table 1.1.3: One-way ANOVA of running distance for each pre-reversal day

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Day 8 | Day 9 | Day 10 | Day 11 |
| Single : Pair: Mirror | F(2,57)= 6.8287 | *p*=0.0022 \*\* | F(2,57)= 6.4206 | *p*=0.0031 \*\*  | F(2,57)= 11.3023 | *p*=0.0001 \*\*\*  | F(2,57)= 18.1259 | *p*<0.0001 \*\*\* |

Table 1.1.4: Post-hoc pairwise comparisons of running distance in each pre-reversal day

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Day 8 | Day 9 | Day 10 | Day 11 |
| Single: Pair | *t*=1.1010 | *p*=0.2755 | *t*=2.2291 | *p*=0.0595 | *t*=4.4879 | *p*=0.0001\*\*\* | *t*=5.9952 | *p*<0.0001\*\*\* |
| Single : Mirror | *t*=3.5700 | *p*=0.0022\*\* | *t*=3.5628 | *p*=0.0022\*\* | *t*=3.7253 | *p*=0.0009\*\*\* | *t*=3.6745 | *p*=0.0011\*\* |
| Pair : Mirror | *t*=2.7155 | *p*=0.0175\* | *t*=1.5796 | *p*=0.1197 | *t*=0.5055 | *p*=0.6152 | *t*=2.0670 | *p*=0.0433\* |

**1.2. Post-reversal data (Day 11–15)**

Table 1.2.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)= 26.4866 | *p*<0.0001 \*\*\*  |
| *Day* | F(2.49,142.06)=8.9664 | *p*=0.0001 \*\*\* |
| *Interaction (group : day)* | F(4.98,142.06)= 0.6555 | *p*=0.6573  |

Table 1.2.2: Post-hoc pairwise comparisons

|  |  |  |
| --- | --- | --- |
| single : pair | *t*= 7.0552 | *p*<0.0001 \*\*\* |
| single : mirror | *t*=5.2823 | *p*<0.0001 \*\*\* |
| pair : mirror | *t*=1.4082 | *p*=0.1645 |

1. **Patch use ratio during feeding (Fig. 2b)**

**2.1. Pre-reversal data (Day 8–11)**

Table 2.1.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)=11.1134 | *p*=0.0001 \*\*\* |
| *Day* | F(2.31,131.45)=2.6651 | *p*=0.0654 |
| *Interaction (group : day)* | F(4.61,131.45)=1.0162 | *p*=0.4076 |

Table 2.1.2: Post-hoc pairwise comparisons

|  |  |  |
| --- | --- | --- |
| single : pair | *t*=4.1281 | *p*=0.0004 \*\*\* |
| single : mirror | *t*=0.2820 | *p*=0.7789 |
| pair : mirror | *t*=3.8266 | *p*= 0.0006 \*\*\* |

**2.2. Post-reversal data (Day 11–15)**

Table 2.2.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)= 2.3037 | *p*= 0.1091 |
| *Day* | F(2.8,159.55)=2.5430 | *p*= 0.0623 |
| *Interaction (group : day)* | F(5.6,159.55)= 3.2434 | *p*= 0.0060 \*\* |

Table 2.2.2: One-way ANOVA for each post-reversal day

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Day 12 | Day 13 | Day 14 | Day 15 |
| single:pair:mirror | F(2,57)= 0.2795 | *p*=0.7572 | F(2,57)= 0.5262 | *p*=0.5937 | F(2,57)= 1.2569 | *p*=0.2923 | F(2,57)= 10.2797 | *p*=0.0002 \*\*\* |

Table 2.2.3: Post-hoc pairwise comparisons for each post-reversal day

|  |  |
| --- | --- |
|  | Day 15 |
| single : pair | *t*= 3.7028 | *p*= 0.0010\*\* |
| single : mirror | *t*= 0.2326 | *p*= 0.8169 |
| pair : mirror | *t*= 3.9514 | *p*= 0.0006\*\*\* |

**3 Multiple regression analysis of the focal subject’s patch-use ratio (as *Y*)**

$$Y= β\_{0}+ β\_{1} × X\_{1}+ β\_{2} × X\_{2}+ r\_{i}$$

**3.1. Pre-reversal data (Day 8–11)**

Table 3.1.1: Effects of the companion chick’s patch-use ratio (as *X1*)

|  |  |  |  |
| --- | --- | --- | --- |
| *Intercept β0* | 0.5243 ± 0.0748 | *t-value* = 7.008 | *p<*0.0001 \*\*\* |
| *Coefficient β1 (X1: companion’s patch-use ratio)*  | 0.2829 ± 0.0995 | ***t-value* = 2.845** | ***p*= 0.00547 \*\*** |
| *Coefficient β2 (X2: Day)* | -0.0007034 ± 0.0053900 | *t-value* = -0.130 | *p*= 0.89655 |

Table 3.1.2: Effects of the subject’s own running distance (as *X1*)

|  |  |  |  |
| --- | --- | --- | --- |
| *Intercept β0* | 0.8025 ± 0.0509 | *t-value* = 15.781 | *p<*0.0001 \*\*\* |
| *Coefficient β1 (X1: subject’s running distance)*  | -0.0003200 ± 0.0002138 | *t-value* = -1.497 | *p*= 0.138 |
| *Coefficient β2 (X2: Day)* | 0.0119304 ± 0.0103379 | *t-value* = 1.154 | *p*= 0.251 |

**3.2. Post-reversal data (Day 12–15)**

Table 3.2.1: Effects of the companion chick’s patch-use ratio (as *X1*)

|  |  |  |  |
| --- | --- | --- | --- |
| *Intercept β0* | 0.2242 ± 0.0389 | *t-value* = 5.770 | *p<*0.0001 \*\*\* |
| *Coefficient β1 (X1: companion’s patch-use ratio)*  | 0.3826 ± 0.0958 | ***t-value* = 3.993** | ***p*= 0.00013 \*\*** |
| *Coefficient β2 (X2: Day)* | -0.01523 ± 0.00496 | ***t-value* = -3.070** | ***p*= 0.00294 \*\*** |

Table 3.2.2: Effects of the subject’s own running distance (as *X1*)

|  |  |  |  |
| --- | --- | --- | --- |
| *Intercept β0* | 0.3426 ± 0.0821 | *t-value* = 4.171 | *p<*0.0001 \*\*\* |
| *Coefficient β1 (X1: subject’s running distance)*  | 0.00005396 ± 0.0002100 | *t-value* = 0.257 | *p*= 0.798 |
| *Coefficient β2 (X2: Day)* | -0.02498 ± 0.00482 | ***t-value* = -5.189** | ***p<*0.0001 \*\*\*** |

**4 Multiple regression analysis of the focal subject’s running distance (as *Y*)**

$$Y= β\_{0}+ β\_{1} × X\_{1}+ β\_{2} × X\_{2}+ r\_{i}$$

**4.1. Pre-reversal data (Day 8–11)**

Table 4.1: Effects of the companion chick’s running distance (as *X1*)

|  |  |  |  |
| --- | --- | --- | --- |
| *Intercept β0* | 45.1655 ± 14.8865 | *t-value* = 3.034 | *p<*0.0031 \*\* |
| *Coefficient β1 (X1: companion’s running distance)*  | 0.79733 ± 0.06258 | ***t-value* = 12.740** | ***p<*0.0001 \*\*\*** |
| *Coefficient β2 (X2: Day)* | 8.17657 ± 3.03566 | ***t-value* = 2.694** | ***p*= 0.0084 \*\*** |

**4.2 Post-reversal data (Day 12–15)**

Table 4.2: Effects of the companion chick’s running distance (as *X1*)

|  |  |  |  |
| --- | --- | --- | --- |
| *Intercept β0* | 76.6546 ± 24.3773 | *t-value* = 3.145 | *p<*0.00224 \*\* |
| *Coefficient β1 (X1: companion’s running distance)*  | 0.79847 ± 0.06243 | ***t-value* = 12.790** | ***p<*0.0001 \*\*\*** |
| *Coefficient β2 (X2: Day)* | 1.19556 ± 1.44896 | *t-value* = 0.825 | *p*= 0.4120 |

**5. Patch-use ratio during feeding on post-hatch Day 12 (Fig. 2c)**

Table 5: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)=0.6398 | *p*=0.5311 |
| *2-min bin* | **F(4.53, 258.32)=31.2626** | ***P*<0.0001\*\*\*** |
| *Interaction (group : bin)* | F(9.06, 258.32)=1.884 | *p*=0. 0541 |

**6. Patch-use ratio before feeding in the post-reversal data (D11–15) (Fig. 2d)**

Table 6.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,55)= 4.1599 | *p*= 0.0208 \*  |
| *Day* | **F(2.66,146.08)=27.4860** | ***p*< 0.0001 \*\*\***  |
| *Interaction (group : day)* | F(5.31,146.08)= 3.0522 | *p*= 0.0104 \* |

Table 6.2: Post-hoc pairwise comparisons

|  |  |  |
| --- | --- | --- |
| single : pair | *t*= 2.7925 | *p*= 0.0215\* |
| single : mirror | *t*= 0.9125 | *p*= 0.3655 |
| pair : mirror | *t*= 1.8576 | *p*= 0.1372 |

Table 6.3: One-way ANOVA for each post-reversal day

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Day 12 | Day 13 | Day 14 | Day 15 |
| single:pair:mirror | **F(****2,55)=5.2799** | ***p*=0.0080 \*\*** | **F(2,55)=6.0571** | ***p*=0.0042 \*****\***  | F(2,55)=1.7144 | *p*=0.1895 | F(2,55)=1.2125 | *p*=0.3053 |

Table 6.4: Post-hoc pairwise comparisons for each post-reversal day

|  |  |  |
| --- | --- | --- |
|  | Day 12 | Day 13 |
| single : pair | ***t*=2.9726** | ***p*=0.0131****\*** | ***t*=3.1836** | ***p*=0.0072\*\*** |
| single : mirror | *t*=0.5147 | *p*=0.6088 | *t*=0.5507 | *p*=0.5841 |
| pair : mirror | ***t*=2.4681** | ***p*= 0.0334\*** | ***t*=2.6439** | ***p*=0.0213\*** |

**7. Patch-use ratio after feeding (Fig. 2e)**

**7.1. Pre-reversal data (Day 8–11)**

Table 7.1.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)=6.0075 | *p*=0.0043 \*\* |
| *Day* | **F(2.74,156.19)=3.6249** | ***p*=0.0173 \*** |
| *Interaction (group : day)* | F(5.48,156.19)=1.3983 | *p*=0.2234 |

Table 7.1.2: Post-hoc pairwise comparisons

|  |  |  |
| --- | --- | --- |
| single : pair | *t*= 3.4662 | *p*= 0.0030\*\* |
| single : mirror | *t*= 1.8306 | *p*= 0.1448 |
| pair : mirror | *t*= 1.5092 | *p*= 0.1448 |

**7.2. Post-reversal data (Day 12~15)**

Table 7.2.1: Two-way repeated measures ANOVA

|  |  |  |
| --- | --- | --- |
| *Group* | F(2,57)= 0.2863 | *p*= 0.7521 |
| *Day* | **F(2.26,128.93)=4.4655** | ***p*= 0.0103 \*** |
| *Interaction (group : day)* | F(4.52,128.93)=1.7844 | *p*= 0.1275 |