Supplementary Material

Here we present details on the statistical analyses reported in the main text. The analysis of two latencies within and across three contexts included a large number of model results that are not directly germane to the main results and would reduce readability of the main text but may be useful for understanding details of the main results.

Analyses of among-individual fixed effects by context and trait

We began our analyses by testing for any major among-individual effects that could bias the dataset. These included effects of sex, block, and between-individual differences in centered mean trial start time, temperature, and date in the year.

Table S1. Results of separate GLM analysis of potential covariates in each context and for both response traits. Date, time, and temperature were individual mean values mean-centered.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Context | Response | Factor1 | F(df) | P-value |
| Baseline | Latency to board | Block1 | 7.4 (2, 138) | 0.0009 |
|  |  | Sex | 0.01 (1,138) | 0.92 |
|  |  | Date1 | 7.1 (1,138) | 0.009 |
|  |  | Time | 0.1 (1,138) | 0.26 |
|  |  | Temperature1 | 1.3 (1,138) | 0.003 |
|  | Board to feed | Block1 | 2.5 (2,137) | 0.09 |
|  |  | Sex | 2.0 (1,137) | 0.16 |
|  |  | Date | 0.8 (1,137) | 0.37 |
|  |  | Time | 0.1 (1,137) | 0.74 |
|  |  | Temperature | 2.5 (1,137) | 0.12 |
| Baseline-Novel object | Latency to board | Block1 | 5.5 (2,163) | 0.005 |
|  |  | Sex | 0.8 (1,163) | 0.36 |
|  |  | Date1 | 6.6 (1,163) | 0.01 |
|  |  | Time | 2.6 (1,163) | 0.11 |
|  |  | Temperature1 | 7.0 (1,163) | 0.009 |
|  | Board to feed | Block1 | 4.6 (2,160) | 0.01 |
|  |  | Sex | 1.1 (1,160) | 0.30 |
|  |  | Date | 0.08 (1,160) | 0.78 |
|  |  | Time | 0.09 (1,160) | 0.76 |
|  |  | Temperature | 2.3 (1, 160) | 0.13 |
| Novel object | Latency to board | Block1 | 5.5 (3,306) | 0.001 |
|  |  | Sex | 0.1 (1,306) | 0.76 |
|  |  | Date | 0.2 (1,306) | 0.62 |
|  |  | Time1 | 18.0 (1,306) | <0.0001 |
|  |  | Temperature | 1.0 (1,306) | 0.32 |
|  | Board to feed | Block1 | 6.5 (3,287) | 0.0003 |
|  |  | Sex | 0.07 (1,287) | 0.79 |
|  |  | Date | 0.2 (1,287) | 0.69 |
|  |  | Time1 | 5.0 (1,287) | 0.03 |
|  |  | Temperature1 | 3.7 (1,287) | 0.06 |
| Novel cue | Latency to board | Block1 | 11.0 (3,341) | <0.0001 |
|  |  | Sex | 0.5 (1,341) | 0.50 |
|  |  | Date1 | 11.4 (1,341) | 0.0008 |
|  |  | Time | 0 (1,341) | 0.99 |
|  |  | Temperature1 | 26.8 (1,341) | <0.0001 |
|  | Board to feed | Block | 1.1 (3,337) | 0.36 |
|  |  | Sex | 7.0 (1,337) | 0.009 |
|  |  | Date | 0.5 (1,337) | 0.49 |
|  |  | Time | 0.1 (1,337) | 0.75 |
|  |  | Temperature1 | 4.1 (1,337) | 0.04 |

1Terms retained in mixed models to test for individual differences

Using the best fit models for among-individual covariates from the analyses in Table S1, we designed models testing for among-individual variance in intercepts and slopes with respect to the number of previous trials experienced in the three main contexts. The most relevant main results were reported in the main text, but the full models are presented in Table S2.

Table S2. Results of separate mixed model analyses including individual intercept and slope with respect to number of prior trials and including significant covariates from Table S1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Context | Response | Factor | Effect size | F  (df) | P-value |
| Baseline | Latency to board | Random: Individual | 0.09 ± 0.09 |  |  |
|  |  | Individual\*Previous trials | 0.006 ± 0.01 |  |  |
|  |  | Covariance | 0.004 ± 0.003 |  |  |
|  |  | Previous trials | -0.17 ± 0.03 | 21.7  (1,28) | <0.0001 |
|  |  | Block | - | 1.8  (2,23.9) | 0.19 |
|  |  | Date | -0.04 ± 0.03 | 1.7 (1,24) | 0.20 |
|  |  | Temperature | -0.01 ± 0.03 | 0.1 (1,24) | 0.83 |
|  | Board to feed | Random: Individual | 0.007 ± 0.05 |  |  |
|  |  | Individual\*Previous trials | - |  |  |
|  |  | Covariance | -0.006 ± 0.01 |  |  |
|  |  | Previous trials | -0.06 ± 0.03 | 2.9  (1,115) | 0.09 |
|  |  | Block | - | 8.7  (2,26.4) | 0.001 |
| Baseline-Novel object | Latency to board | Random: Individual | 0.18 ± 0.07 |  |  |
|  |  | Individual\*Previous trials | 0.33 ± 0.15 |  |  |
|  |  | Covariance | 0.12 ± 0.08 |  |  |
|  |  | Object | 0.78 ± 0.14 | 30.9  (1,28.6) | <0.0001 |
|  |  | Block | - | 1.6  (2,24.3) | 0.23 |
|  |  | Date | -0.03 ± 0.02 | 1.5  (1,24.5) | 0.23 |
|  |  | Temp | -0.005 ± 0.03 | 0.04  (1,24.5) | 0.85 |
|  | Board to feed | Random: Individual | 0.06 ± 0.04 |  |  |
|  |  | Individual\*Previous trials | 0.20 ± 0.14 |  |  |
|  |  | Covariance | 0.13 ± 0.07 |  |  |
|  |  | Object | 0.80 ± 0.13 | 37.7  (1,25.6) | <0.0001 |
|  |  | Block | - | 8.9  (2,26.3) | 0.001 |
| Novel object | Latency to board | Random: Individual | 0.30 ± 0.11 |  |  |
|  |  | Individual\*Previous trials | 0.003 ± 0.005 |  |  |
|  |  | Covariance | 0.003 ± 0.02 |  |  |
|  |  | Previous trials | -0.08 ± 0.02 | 10.0  (1,39.6) | 0.003 |
|  |  | Block | - | 1.3 (3,33.3) | 0.29 |
|  |  | Time | 0.36 ± 0.17 | 4.4  (1,34.7) | 0.04 |
|  | Board to feed | Random: Individual | 0.14 ± 0.07 |  |  |
|  |  | Individual\*Previous trials | 0.009 ± 0.007 |  |  |
|  |  | Covariance | 0.015 ± 0.016 |  |  |
|  |  | Previous trials | -0.14 ± 0.03 | 22.0  (1,34.2) | <0.0001 |
|  |  | Block | - | 2.6 (3,32) | 0.07 |
|  |  | Time | 0.11 ± 015 | 0.06 (1,34.5) | 0.46 |
|  |  | Temperature | -0.01 ± 0.01 | 0.5 (1,32.1) | 0.50 |
| Novel cue | Latency to board | Random: Individual | 0.22 ± 0.08 |  |  |
|  |  | Individual\*Previous trials | 0.003 ± 0.005 |  |  |
|  |  | Covariance | -0.018 ± 0.016 |  |  |
|  |  | Previous trials | -0.01 ± 0.02 | 0.25  (1,32.2) | 0.62 |
|  |  | Block | - | 2.1 (3,30.9) | 0.12 |
|  |  | Date | 0.002 ± 0.001 | 2.6 (1,33.2) | 0.12 |
|  |  | Temperature | 0.03 ± 0.01 | 5.0 (1,30.6) | 0.03 |
|  | Board to feed | Random: Individual | 0.19 ± 0.08 |  |  |
|  |  | Individual\*Previous trials | 0.01 ± 0.008 |  |  |
|  |  | Covariance | -0.029 ± 0.022 |  |  |
|  |  | Previous trials | -0.22 ± 0.03 | 49.1  (1,34.7) | <0.0001 |
|  |  | Temperature | 0.012 ± 0.004 | 9.5 (1,34.7) | 0.004 |

Because some trials resulted in the subject either never landing on the board, or, if they landed, never feeding before the end of the video, we scored these as having latencies that extended to the end of the video. These truncated cases were modestly common for both response variables in the novel object trials and for the latency from board to feed in the novel cue trials. Including the truncated trials is logically more appropriate than omitting them, since these subjects are likely to have been highly responsive to the context. However, to assess if these trials are driving the main results, we redid the analyses without them. The results are shown in Table S3 for the three context-by-response-trait situations where there were at least several such cases. A few parameters change significance as a result, but their overall magnitude is generally similar to the full analysis, so we report only the results from Table S2 in the main text.

Table S3. Analyses of both responses in the novel object context and latency to feed in the novel cue contexts as in Table S2 except that all cases were omitted in which the subject never arrived at the board (for response = latency to board) or never fed (for response = latency from board to feed).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Context | Response | Factor | Effect size | F  (df) | P-value |
| Novel object | Latency to board | Random: Individual | 0.25 ± 0.10 |  |  |
|  |  | Individual\*Previous trials | 0.002 ± 0.005 |  |  |
|  |  | Covariance | 0.001 ± 0.02 |  |  |
|  |  | Previous trials | -0.08 ± 0.02 | 11.3  (1,36.2) | 0.002 |
|  |  | Block | - | 1.8 (3,31.2) | 0.18 |
|  |  | Time | 0.35 ± 0.16 | 4.9  (1,32.3) | 0.03 |
|  | Board to feed | Random: Individual | 0.10 ± 0.06 |  |  |
|  |  | Individual\*Previous trials | 0.004 ± 0.006 |  |  |
|  |  | Covariance | 0.017 ± 0.014 |  |  |
|  |  | Previous trials | -0.12 ± 0.03 | 20.9  (1,32.4) | <0.0001 |
|  |  | Block | - | 3.0 (3,28) | 0.048 |
|  |  | Time | 0.12 ± 0.14 | 0.8 (1,30.8) | 0.38 |
|  |  | Temperature | -0.01 ± 0.01 | 0.8 (1,27.9) | 0.37 |
| Novel cue | Board to feed | Random: Individual | 0.08 ± 0.06 |  |  |
|  |  | Individual\*Previous trials | 0.005 ± 0.007 |  |  |
|  |  | Covariance | -0.007 ± 0.017 |  |  |
|  |  | Previous trials | -0.18 ± 0.03 | 47.0  (1,34.2) | <0.0001 |
|  |  | Temperature | 0.009 ± 0.003 | 8.7 (1,33.9) | 0.006 |

Analyses of within-individual and among-individual covariances between traits or contexts.

Here we present the full analyses of covariances that are reported in the main text. We also include the SAS code that was used to generate the results. The first analysis was to analyze within-individual covariance in logged latency to board (logLTB) and logged latency from board to feed (logBTF) regardless of context, which produces the overall covariance between them. The initial analysis did not include any covariates, despite knowing that multiple covariates (block, start time, number of previous trials) affected both response traits in many contexts (Tables S1 and S2). The following is the SAS code used to generate these results from a data file constructed as described in Dingemanse and Dochtermann (2013).

**Proc** **mixed** data=HOSP.Covary Method=reml covtest;

class ID TRAITW OBS;

model Response=TRAITW /noint solution;

random TRAITW /type=un sub=ID g;

repeated TRAITW OBS /type=un@cs sub=ID r rcorr;

**run**;

The main results were obtained from the covariance parameter estimates, and are summarized in Table S4.

Table S4. Among-individual variances and covariances in logged latency to board (logLTB) and logged latency from board to feed (logBTF) across all contexts extracted from a bivariate model with no covariates.

| Parameter | Estimate | Standard Error |
| --- | --- | --- |
| Among-individual variance in logLTB | 0.105 | 0.030 |
| Covariance in intercepts (logLTB, logBTF) | 0.057 | 0.029 |
| Among-individual variance in logBTF | 0.200 | 0.050 |
| Within-individual variance in logLTB | 0.534 | 0.028 |
| Within-individual covariance (logLTB, logBTF) | 0.053 | 0.019 |
| Within-individual variance in logBTF | 0.457 | 0.023 |

We next added the main within-individual covariate, number of previous trials (TrialsPrevious) to the model.

**Proc** **mixed** data=HOSP.Covary Method=reml covtest;

class ID TRAITW OBS;

model Response=TRAITW TrialsPrevious TrialsPrevious\*TRAITW/noint solution;

random TRAITW /type=un sub=ID g;

repeated TRAITW OBS /type=un@cs sub=ID r rcorr;

**run**;

Table S5. Among- and within-individual covariances between logged latency to board (logLTB) and latency from board to feed (logBTF) with number of previous trials in that context added as a covariate.

| Parameter | Estimate | Standard Error |
| --- | --- | --- |
| Among-individual variance in logLTB | 0.104 | 0.030 |
| Covariance in intercepts (logLTB, logBTF) | 0.058 | 0.029 |
| Among-individual variance in logBTF | 0.194 | 0.049 |
| Within-individual variance in logLTB | 0.484 | 0.025 |
| Within-individual covariance (logLTB, logBTF) | 0.030 | 0.018 |
| Within-individual variance in logBTF | 0.450 | 0.023 |

These analyses lumped the responses across contexts into one analysis. We also explored the variance-covariance structure among the 6 context-response combinations treated as separate traits. Below is the code to produce this analysis, where “Trait” has six levels.

**Proc** **mixed** data=HOSP.Covary Method=reml covtest;

class ID TRAIT OBS;

model Response=TRAIT/noint solution;

random TRAIT /type=un sub=ID g gcorr;

repeated TRAIT OBS /type=un@cs sub=ID r rcorr;

**run**;

Table S6. Among- and within-individual variances and covariances in the two response traits (logged latency to board, logLTB, and logged latency from board to feed, logBTF) within and among three contexts (baseline, novel cue, and novel object), generated from a multivariate mixed model with no fixed effects.

| Parameter | Estimate | Standard error |
| --- | --- | --- |
| **Among-individual** |  |  |
| Variance in baseline logBTF | 0.038 | 0.022 |
| Baseline covariance (logBTF, logLTB) | 0.034 | 0.024 |
| Variance in baseline logLTB | 0.145 | 0.049 |
| Covariance (baseline logBTF, novel cue logBTF) | 0.050 | 0.030 |
| Variance in novel cue logBTF | 0.207 | 0.054 |
| Covariance (baseline logLTB, novel cue logLTB | 0.154 | 0.043 |
| Novel cue covariance (logBTF, logLTB) | 0.081 | 0.039 |
| Variance novel cue logLTB | 0.207 | 0.050 |
| Covariance (baseline logBTF, novel object logBTF) | 0.001 | 0.030 |
| Covariance (novel cue logBTF, novel object logBTF) | 0.090 | - |
| Variance novel object logBTF | 0.323 | 0.082 |
| Covariance (baseline logLTB, novel object logLTB) | 0.119 | 0.050 |
| Covariance (novel cue logLTB, novel object logLTB) | 0.164 | 0.053 |
| Novel object covariance (logBTF, logLTB) | 0.130 | 0.063 |
| Variance novel object logLTB | 0.362 | 0.086 |
| **Within-individual** |  |  |
| Baseline residual logBTF | 0.316 | 0.042 |
| Baseline covariance (logBTF, logLTB) | 0.028 | 0.033 |
| Baseline residual logLTB | 0.382 | 0.050 |
| Novel cue residual logBTF | 0.510 | 0.041 |
| Novel cue covariance (logBTF, logLTB) | 0.040 | 0.024 |
| Novel cue residual logLTB | 0.293 | 0.023 |
| Novel object residual logBTF | 0.340 | 0.030 |
| Novel object covariance (logBTF, logLTB) | -0.009 | 0.021 |
| Novel object residual logLTB | 0.312 | 0.027 |

The results in Table S6 were obtained from a model with no fixed effects. Because each trait and context had a slightly different array of among-individual covariates, we did not add any back into the model. However, nearly every trait by context response did depend on the number of previous trials within the context. We therefore included this within-individual covariate into the model. Because the relationship likely differed among trait and context, we included an interaction between the 6 level “TRIAT” variable and TrialsPrevious. The code used was:

**Proc** **mixed** data=HOSP.Covary Method=reml covtest;

class ID TRAIT OBS;

model Response=TRAIT TrialsPrevious Trait\*TrialsPrevious/noint solution;

random TRAIT /type=un sub=ID g gcorr;

repeated TRAIT OBS /type=un@cs sub=ID r rcorr;

**run**;

Table S7. Among- and within-individual variances and covariances in the two response traits (logged latency to board, logLTB, and logged latency from board to feed, logBTF) within and among three contexts (baseline, novel cue, and novel object), generated from a multivariate mixed model with number of previous trials (TrialsPrevious) and its interaction with TRAIT as a covariate.

| Parameter | Estimate | Standard error |
| --- | --- | --- |
| **Among-individual** |  |  |
| Variance in baseline logBTF | 0.013 | 0.023 |
| Baseline covariance (logBTF, logLTB) | 0.038 | 0.025 |
| Variance in baseline logLTB | 0.130 | 0.050 |
| Covariance (baseline logBTF, novel cue logBTF) | 0.049 | 0.030 |
| Variance in novel cue logBTF | 0.169 | 0.053 |
| Covariance (baseline logLTB, novel cue logLTB | 0.154 | 0.043 |
| Novel cue covariance (logBTF, logLTB) | 0.071 | 0.038 |
| Variance novel cue logLTB | 0.176 | 0.050 |
| Covariance (baseline logBTF, novel object logBTF) | -0.004 | 0.030 |
| Covariance (novel cue logBTF, novel object logBTF) | 0.088 | 0.050 |
| Variance novel object logBTF | 0.304 | 0.084 |
| Covariance (baseline logLTB, novel object logLTB) | 0.128 | 0.051 |
| Covariance (novel cue logLTB, novel object logLTB) | 0.170 | 0.053 |
| Novel object covariance (logBTF, logLTB) | 0.146 | 0.065 |
| Variance novel object logLTB | 0.343 | 0.087 |
| **Within-individual** |  |  |
| Baseline residual logBTF | 0.337 | 0.045 |
| Baseline covariance (logBTF, logLTB) | 0.005 | 0.032 |
| Baseline residual logLTB | 0.345 | 0.045 |
| Novel cue residual logBTF | 0.448 | 0.037 |
| Novel cue covariance (logBTF, logLTB) | 0.044 | 0.023 |
| Novel cue residual logLTB | 0.331 | 0.025 |
| Novel object residual logBTF | 0.352 | 0.031 |
| Novel object covariance (logBTF, logLTB) | -0.044 | 0.022 |
| Novel object residual logLTB | 0.316 | 0.027 |

We could not analyze the variance and covariance in the above model modified to include random slopes over the number of previous trails because the model did not converge. Instead, we reverted to lumping all three contexts together and analyzing a bivariate random regression. The SAS code for this is

**Proc** **mixed** data=HOSP.Covary Method=reml covtest;

class ID TRAITW OBS;

model Response=TRAITW TrialsPrevious TrialsPrevious\*TRAITW/noint solution;

random TRAITW TrialsPrevious\*TraitW/type=un sub=ID g;

repeated TRAITW OBS /type=un@cs sub=ID r rcorr;

**run**;

Table S8. Among-individual variances (along diagonal) and covariances in intercepts and slopes with respect to number of previous trials for two responses traits from a bivariate mixed model (those in brackets are for cross-trait, cross-context covariances).

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Intercept variance and covariance** | | **Slope variance, covariance, and intercept-slope covariance** | |
| **Effect** | **logBTF** | **logLTB** | **logBTF** | **logLTB** |
| logBTF-Intercept | 0.081 ± 0.036 | 0.090 ± 0.036 | 0.002 ± 0.009 | [-0.012 ± 0.006] |
| logLTB-Intercept |  | 0.184 ± 0.059 | [-0.008 ± 0.011] | 0.002 ± 0.009 |
| logBTF-Slope |  |  | 0.003 ± 0.003 | 0.002 ± 0.002 |
| logLTB-Slope |  |  |  | 0.0 ± 0 |