**Supplementary materials S**

*S1: Training phases*

**Training phase 1**

As none of the macaques had experience with touchscreen experiments prior to the beginning of the data collection, all the macaques had to complete two training phases. The first training phase used a rectangular transparent Plexiglas sheet (42 x 30 cm) with a plastic red square target (10 x 12 cm) moved by hand. Monkeys were progressively rewarded for approaching the Plexiglas sheet, touching the target and following it as it moved. This phase was judged as complete if the macaques followed the target 20 times in a row. Two females did not complete this training stage as they gave birth during the training period, two males could not reach the success criterion.

**Training phase 2**

After completion of the first training phase, the touchscreen was introduced. The aim of training phase 2 was to be trained to touch a target on the screen.

*Stimuli*

The target was a red (RGB 255, 0, 0) rectangle of a maximum of 1200 x 1000 pixels (ca. 32 x 26 cm) and was gradually reduced to 360 x 500 pixels (ca. 10 x 13 cm).

*General Procedure*

When the program was launched, the experimenter entered the name of the individual, the number of trials per session, the size of the target and the time limit to complete the task. Every session was initiated by the subject touching a red cross located in the centre of the screen, starting the time recording. Then, the target was displayed in the middle of a white background (RGB 255, 255, 255). For the first 30 trials a picture of peanuts was displayed inside the target to motivate the macaques to touch it. Once the subject touched the target, a high-pitched chime (composed of 3 sound frequencies: 800, 1300 and 2000 Hz) was played, the timer was stopped, and the reward was given. After an inter-trial of 200 ms, with only the white background displayed, the next trial was presented. Based on a pilot study (N = 4 subjects), we set up a maximum response time of 35 s. This time period allowed the subject to display a behavioural response, control it, and continue the task. If the subject left the testing area or was not focusing attention on the screen the session was aborted. If the target was not touched within the time limit (35 s), the timer was paused, a red cross appeared in the centre of the screen until the session was resumed by touching it. The size of the target was gradually reduced to 360 x 500 pixels (ca. 10 x 13 cm). Once the macaques performed successfully 20 times in a row with the target in the centre of the screen, the target was displayed randomly at the far left or right of the screen. This phase was judged as complete if the macaque followed the target 20 trials in a row. If the subject stayed inactive for more than 5 min the session was stopped and continued the next testing day, if the subject did not participate for three testing days in a row the subject was excluded from the task. The training phase 2 was completed by 21 subjects (12 males, 9 females) who therefore progressed to the experimental phase. Six subjects abandoned this training phase as they stayed at distance from the screen or gave birth in the meantime.

**Modified Stroop Task**

Table S1

All sessions

1. **Variables having a significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model sex\*stimulus | 7 |  |  |
| Model optimum | 10 | 51.517 | **3.797e-11 \*\*\*** |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model session | 9 |  |  |
| Model optimum | 10 | 10.931 | **9.458e-04\*\*\*** |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model order of blocks | 9 |  |  |
| Model optimum | 10 | 21.802 | **3.024e-06 \*\*\*** |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model trial | 9 |  |  |
| Model optimum | 10 | 21.408 | **3.711e-06 \*\*\*** |

Between the optimum model and the baseline (χ2 1  = 64.301, P = 6.63e-11).

1. **Variables having no significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model optimum | 10 |  |  |
| Model age | 11 | 1.607 | 0.205 |
| Model rank | 12 | 0.069 | 0.792 |

Result of the anovas using the backward regression method for the Distraction control score in all the sessions. a)Variables having a significant effect on the models: interaction sex\*stimulus (if it was either a picture or no picture), session, the order of the blocks and the trial number. The model optimum contains all variables having a significant effect on the model. b)Variables having no significant effect on the models (age and rank).

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

*Table S2*

*Session 1 block 1*

1. **Males**

Df Chisq Pr(>Chisq)

Model type

of pictures 5

Model optimum 8 16.186 **1.039e-03 \*\***

Df Chisq Pr(>Chisq)

Model trial 7

Model optimum 8 5.585 **0.018\***

Between the optimum model and the baseline (χ2 1  = 21.64, N=21, P = 2.364e-04\*\*\*).

**b) Females**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Baseline | 4 |  |  |
| Model rank | 5 | 0.045 | 0.832 |
| Model age | 6 | 0.029 | 0.864 |
| Model trial | 7 | 0.021 | 0.885 |
| Model type of picture | 10 | 0.734 | 0.865 |

Result of the anovas between models using the backward regression method for the Distraction control score in session 1, block 1. For males (a) the variable type of picture and the variable trial had a significant effect on the models. For females none of the variables had a significant effect on the models.

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

Table S3

***Males, Session 1, Block 1***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Estimate*** | ***Std. Error*** | ***z value*** | ***Pr(>|z|)*** |
| *Control - Neutral* | *-3.838* | *3.958* | *-0.970* | *0.7606* |
| *Object - Neutral* | *-2.643* | *5.415* | *-0.488* | *0.9604* |
| *Threat - Neutral* | *14.506* | *5.023* | *2.888* | ***0.0203 \**** |
| *Object - Control* | *1.194* | *4.529* | *0.264* | *0.9933* |
| *Threat - Control* | *18.344* | *4.145* | *4.425* | ***<0.001 \*\*\**** |
| *Threat - Object* | *17.150* | *5.553* | *3.088* | ***0.0104*** *\** |

***Females, Session 1, Block 1***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | ***Estimate*** | ***Std. Error*** | ***z value*** | ***Pr(>|z|)*** |
| *Control - Neutral* | *1.5009* | *2.3398* | *0.641* | *0.918* |
| *Object - Neutral* | *0.9831* | *2.6541* | *0.370* | *0.983* |
| *Threat - Neutral* | *2.1925* | *2.6891* | *0.815* | *0.846* |
| *Object - Control* | *-0.5177* | *2.3117* | *-0.224* | *0.996* |
| *Threat - Control* | *0.6916* | *2.3441* | *0.295* | *0.991* |
| *Threat - Object* | *1.2093* | *2.6257* | *0.461* | *0.967* |

Result of the Tukey HSD test comparing each type of picture: Control ( no picture presented), Neutral (a picture of a neutral conspecific face presented), Threatening (a picture of the face of a threatening conspecific is presented), Object (a picture of an object).

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

**Go/No-go**

Table S4

**Accuracy on a trial**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictor for success** | **Df** | **Chisq** | **Pr(>Chisq)** |
| Baseline | 2 |  |  |
| Model session | 3 | 2.937 | 0.087 |
| Model rank | 4 | 0.824 | 0.364 |
| Model age | 5 | 0.334 | 0.563 |
| Model trial | 6 | 0.209 | 0.648 |
| Model sex | 7 | 0.064 | 0.801 |

Result of the anovas between models using the backward regression method for the success on a No-go trial in the Go/No-go task. None of the variables presented had a significant effect on the model.

Table S5

**Response latency**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictor for log(response latency)** | **Df** | **Chisq** | **Pr(>Chisq)** |
| Baseline | 3 |  |  |
| Model sex | 4 | 1.470 | 0.225 |
| Model rank | 5 | 3.099 | 0.078 |
| Model trial | 6 | 0.276 | 0.599 |
| Model age | 7 | 0.202 | 0.653 |
| Model session | 8 | 0.063 | 0.802 |

Result of the anovas between models using the backward regression method for the response latency on a No-go trial in the Go/No-go task. None of the variables had a significant effect on the model.

**Reversal learning**

**Number of trials to learn the rules**

Table S6

1. **Variables having a significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model rule | 3 |  |  |
| Model optimum | 4 | 32.989 | **9.267e-09 \*\*\*** |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model age | 3 |  |  |
| Model optimum | 4 | 4.5263 | **0.0334\*** |

Between the optimum model and the baseline (χ2 1  = 37.514, N=19, P = 7.146e-09 \*\*\*1.09e-12).

1. **Variables having no significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Predictor** | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model optimum | 4 |  |  |
| Model sex | 5 | 0.427 | 0.513 |
| Model rank | 6 | 0.323 | 0.570 |
|  |  |  |  |

Interaction between rule ad age were tested with anovas between the models with rule\*age and rule + age as independent variable (χ2 1  = 0.101, N =19, P = 0.751).

Result of the anovas using the backward regression method for the number of trials to learn the rules. a)Variables having a significant effect on the models: rule and age. The model optimum contains all variables having a significant effect on the model. b)Variables having no significant effect on the models (sex and rank).

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

**Accuracy on a trial**

Table S7

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***Df*** | ***Chisq*** | ***Pr(>Chisq)*** |
| *Baseline* | *2* |  |  |
| *Model session* | *3* | 9.072 | **0.003\*\*** |
| *Model age* | *4* | 2.908 | 0.088 |
| *Model rule* | *5* | 3.376 | 0.066 |
| *Model sex* | *6* | 1.556 | 0.212 |
| *Model trial* | *7* | 1.155 | 0.283 |
| *Model rank* | *8* | 0.008 | 0.927 |

Result of the anovas between models using the backward regression method for the accuracy on a trial in the Reversal learning task. The variable session had a significant effect on the model.

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

Table S8

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Predictor** | **Estimate** | **Std. Error** | **z value** | **Pr(>|z|)** |
| (Intercept) | 0.932 | 0.204 | 4.568 | 0.000 |
| Rule (reversed) | -0.137 | 0.071 | -1.937 | 0.053 |
| Sex (female) | -0.182 | 0.133 | -1.364 | 0.173 |
| Age | -0.034 | 0.016 | -2.208 | 0.027 |
| Rank (low) | 0.023 | 0.153 | 0.149 | 0.882 |
| Session | 0.052 | 0.018 | 2.863 | **0.004\*\*** |
| Trial | 0.002 | 0.003 | 0.775 | 0.438 |

Results of the GLMM for the probability of success on a trial in the reversal learning task. Explanatory factors were divided in 2 categories of determinants: individual characteristics (sex, age and rank) and experimental determinants (acquisition rule or reversed rule, trial and session). All full models included the individual ID as random factor. The Estimates (representing the change in the dependent variable relative to the baseline category of each predictor variable), Standard Error, z-value and p-value using maximum likelihood method. The variable session had a significant main effect on the models.

\* p < 0.05, \*\* p < 0.01

**Number of taps on the wrong stimulus**

*Table 9*

1. **Variables having a significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model session | 5 |  |  |
| Model optimum | 6 | 13.819 | **2.02-04\*\*\*** |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model trial | 5 |  |  |
| Model optimum | 6 | 5.999 | **1.140e-02\*** |

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model rule | 5 |  |  |
| Model optimum | 6 | 9.043 | **2.638-03\*\*** |

Between optimum model and baseline (χ2 1  = 27.979, N=19, P = 3.669e-06).

1. **Variables having no significant effect on the model:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Df** | | | **Chisq** | | **Pr(>Chisq)** | |
|  |  | | |  | |  | |
| Model optimum | | 6 |  | |  | |
| Model age | | 7 | 2.573 | | 0.109 | |
| Model sex | 8 | | | 0.472 | | 0.492 | |
| Model rank | 9 | | | 0.006 | | 0.937 | |

Result of the anovas between models containing variables having significant effect for the log 10 of the number of taps on a successful trial. a)Variables having a significant effect on the models: session, trial and rule. The model optimum contains all variables having a significant effect on the model. b)Variables having no significant effect on the models (age, sex and rank).

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

*Table S10*

*Log10 of Number of taps when trial was failed*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Predictor** | **Estimate** | **Std. Error** | **t value** | **Pr(>|t|)** |
| (Intercept) | 0.817 | 0.035 | 23.571 | 9.052e-16 |
| Rule (reversed) | 0.039 | 0.014 | 2.888 | **0.004\*\*** |
| Sex (female) | -0.013 | 0.023 | -0.573 | 0.575 |
| Age | 0.003 | 0.003 | 1.094 | 0.296 |
| Rank (low) | 0.002 | 0.026 | 0.096 | 0.924 |
| Trial | -0.001 | 0.001 | -2.454 | **0.014\*** |
| Session | -0.013 | 0.003 | -3.795 | **1.632e-04\*\*\*** |

Results of LMMs for the number taps when a trial was failed. Explanatory factors were divided in 2 categories of determinants: individual characteristics (sex, age and rank) and experimental determinants (acquisition rule or reversed rule, trial and session). All full models included the individual ID as random factor. The Estimates (representing the change in the dependent variable relative to the baseline category of each predictor variable), Standard Error, t-value and p-value using maximum likelihood method. The variables in bold had a significant effect on the models.

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

*Table S11*

1. **Variables having a significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model sex | 4 |  |  |
| Model optimum | 5 | 7.212 | **0.007\*\*\*** |
|  |  |  |  |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model rule | 4 |  |  |
| Model optimum | 5 | 36.070 | **1.906e-09 \*\*\*** |

Between optimum model and baseline (χ2 1  = 39.294, N=19, P = 2.93e-09).

1. **Variables having no significant effect on the model:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Df** | **Chisq** | **Pr(>Chisq)** |
| Model optimum | 5 |  |  |
| Model trial | 6 | 4.439 | 0.109 |
| Model session | 7 | 0.092 | 0.762 |
| Model age | 8 | 0.007 | 0.933 |
| Model rank | 9 | 0 | 1 |

Result of the anovas between models containing variables having significant effect for response latency successful trial. a)Variables having a significant effect on the models: sex and rule. The model optimum contains all variables having a significant effect on the model. b)Variables having no significant effect on the models (age, trial, session and rank).

\* p < 0.05, \*\* p< 0.01, \*\*\* p < 0.001

*Table S12*

*Log of Response latency on a successful trial*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Predictor** | **Estimate** | **Std. Error** | **t value** | **Pr(>|t|)** |
| (Intercept) | 7.738 | 0.346 | 22.382 | 7.880e-17 |
| Rule (reverse) | 0.213 | 0.037 | 5.701 | **1.323e-08\*\*\*** |
| Sex (female) | 0.373 | 0.257 | 1.452 | 0.166 |
| Age | 0.001 | 0.028 | 0.047 | 0.963 |
| Rank (low) | 0.254 | 0.290 | 0.874 | 0.395 |
| Trial | 0.000 | 0.002 | -0.301 | 0.763 |
| session | 0.027 | 0.010 | 2.672 | **0.008** |

Results of LMMs for the log of response latency on a correct trial. Explanatory factors were divided in individual (sex, age, rank) and experimental determinants (rule, trial and session). All full models included the individual ID as random factor. The Estimates (representing the change in the dependent variable relative to the baseline category of each predictor variable), Standard Error, t-value and p-value using maximum likelihood method. The variable in bold had a significant effect on the models