**Supplementary Material – Cluster Analysis**

**Main Analysis**

**Table S\_CA1.** Quick learners’ model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | SE | Z | p | OR | 95% CI |
| Block1 | 0.16 | 0.16 | 1.01 | .36 | 1.17 | 0.86, 1.60 |
| **Block2** | 3.09 | 0.28 | 11.07 | **<.001** | 21.96 | 12.71, 37.95 |
| **Block3** | 3.39 | 0.31 | 10.78 | **<.001** | 29.54 | 15.97, 54.66 |
| **Block4** | 3.05 | 0.28 | 10.74 | **<.001** | 21.19 | 12.14, 36.99 |
| **Block1:Matrix within block** | 0.09 | 0.01 | 9.02 | **<.001** | 1.09 | 1.07, 1.11 |
| Block2:Matrix within block | -0.02 | 0.01 | -1.32 | .29 | 0.98 | 0.95, 1.01 |
| Block3:Matrix within block | -0.02 | 0.02 | -1.23 | .29 | 0.98 | 0.95, 1.01 |
| Block4:Matrix within block | -0.01 | 0.01 | -0.59 | .55 | 0.99 | 0.96, 1.02 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA2.** Slow learners’ model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | SE | Z | p | OR | 95% CI |
| Block1 | 0.01 | 0.18 | 0.04 | .97 | 1.01 | 0.71, 1.42 |
| Block2 | 0.27 | 0.18 | 1.50 | .21 | 1.32 | 0.92, 1.88 |
| **Block3** | 1.59 | 0.23 | 6.84 | **<.001** | 4.89 | 3.10, 7.70 |
| **Block4** | 2.37 | 0.28 | 8.37 | **<.001** | 10.74 | 6.16, 18.72 |
| Block1:Matrix within block | 0.01 | 0.01 | 0.93 | .47 | 1.01 | 0.99, 1.03 |
| **Block2:Matrix within block** | 0.04 | 0.01 | 4.03 | **<.001** | 1.04 | 1.02, 1.06 |
| Block3:Matrix within block | 0.02 | 0.01 | 1.65 | .20 | 1.02 | 1.00, 1.05 |
| Block4:Matrix within block | 0.00 | 0.02 | -0.14 | .97 | 1.00 | 0.97, 1.03 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA3**. Non-learners’ model

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | SE | Z | p | OR | 95% CI |
| Block1 | -0.05 | 0.10 | -0.48 | .97 | 0.95 | 0.78, 1.16 |
| Block2 | 0.00 | 0.10 | -0.04 | .97 | 1.00 | 0.82, 1.21 |
| Block3 | 0.05 | 0.10 | 0.46 | .97 | 1.05 | 0.86, 1.28 |
| Block4 | -0.12 | 0.10 | -1.22 | .97 | 0.88 | 0.72, 1.08 |
| Block1:Matrix within block | 0.00 | 0.01 | 0.72 | .97 | 1.00 | 0.99, 1.02 |
| Block2:Matrix within block | 0.00 | 0.01 | 0.27 | .97 | 1.00 | 0.99, 1.01 |
| Block3:Matrix within block | 0.00 | 0.01 | -0.17 | .97 | 1.00 | 0.99, 1.01 |
| Block4:Matrix within block | 0.01 | 0.01 | 0.92 | .97 | 1.01 | 0.99, 1.02 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA4.** A unified model of all learning clusters

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | SE | Z | p | OR | 95% CI |
| Non-learners: Block 1 | -0.05 | 0.10 | -0.47 | .82 | 0.95 | 0.78, 1.17 |
| Slow learners: Block 1 | 0.01 | 0.16 | 0.05 | .97 | 1.01 | 0.73, 1.38 |
| Quick learners: Block 1 | 0.15 | 0.14 | 1.06 | .54 | 1.16 | 0.88, 1.53 |
| Non-learners: Block 2 | 0.00 | 0.10 | -0.04 | .97 | 1.00 | 0.81, 1.22 |
| Slow learners: Block 2 | 0.27 | 0.17 | 1.59 | .30 | 1.31 | 0.94, 1.83 |
| **Quick learners: Block 2** | 3.01 | 0.27 | 11.24 | **<.001** | 20.37 | 12.04, 34.47 |
| Non-learners: Block 3 | 0.05 | 0.10 | 0.45 | .82 | 1.05 | 0.85, 1.29 |
| **Slow learners: Block 3** | 1.56 | 0.22 | 7.04 | **<.001** | 4.77 | 3.09, 7.37 |
| **Quick learners: Block 3** | 3.31 | 0.30 | 10.87 | **<.001** | 27.34 | 15.06, 49.65 |
| Non-learners: Block 4 | -0.12 | 0.10 | -1.19 | .47 | 0.88 | 0.72, 1.08 |
| **Slow learners: Block 4** | 2.34 | 0.28 | 8.51 | **<.001** | 10.40 | 6.07, 17.84 |
| **Quick learners: Block 4** | 2.98 | 0.27 | 10.88 | **<.001** | 19.66 | 11.50, 33.62 |
| Non-learners: Block 1: Matrix within block | 0.00 | 0.01 | 0.73 | .70 | 1.00 | 0.99, 1.02 |
| Slow learners: Block 1: Matrix within block | 0.01 | 0.01 | 0.92 | .57 | 1.01 | 0.99, 1.03 |
| **Quick learners: Block 1: Matrix within block** | 0.08 | 0.01 | 8.92 | **<.001** | 1.09 | 1.07, 1.11 |
| Non-learners: Block 2: Matrix within block | 0.00 | 0.01 | 0.27 | .94 | 1.00 | 0.99, 1.01 |
| **Slow learners: Block 2: Matrix within block** | 0.04 | 0.01 | 4.00 | **<.001** | 1.04 | 1.02, 1.06 |
| Quick learners: Block 2: Matrix within block | -0.02 | 0.01 | -1.31 | .45 | 0.98 | 0.95, 1.01 |
| Non-learners: Block 3: Matrix within block | 0.00 | 0.01 | -0.17 | .97 | 1.00 | 0.99, 1.01 |
| Slow learners: Block 3: Matrix within block | 0.02 | 0.01 | 1.64 | .30 | 1.02 | 1.00, 1.05 |
| Quick learners: Block 3: Matrix within block | -0.02 | 0.02 | -1.23 | .47 | 0.98 | 0.95, 1.01 |
| Non-learners: Block 4: Matrix within block | 0.01 | 0.01 | 0.92 | .57 | 1.01 | 0.99, 1.02 |
| Slow learners: Block 4: Matrix within block | 0.00 | 0.02 | -0.14 | .97 | 1.00 | 0.97, 1.03 |
| Quick learners: Block 4: Matrix within block | -0.01 | 0.01 | -0.59 | .78 | 0.99 | 0.96, 1.02 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA5**. Group comparison in a mixed-effects linear model with ***non-learners*** as the reference group

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | SE | Z | p | OR | 95% CI |
| Intercept | 0.03 | 0.06 | 0.50 | .62 | 1.03 | 0.92, 1.15 |
| Matrix number (1-120) | 0.00 | 0.00 | -0.49 | .62 | 1.00 | 1.00, 1.00 |
| **Slow learners** | -0.27 | 0.11 | -2.48 | **.020** | 0.77 | 0.62, 0.95 |
| **Quick learners** | 1.15 | 0.11 | 10.74 | **<.001** | 3.14 | 2.55, 3.87 |
| **Matrix number (1-120) - Slow learners** | 0.03 | 0.00 | 15.45 | **<.001** | 1.03 | 1.02, 1.03 |
| **Matrix number (1-120) - Quick learners** | 0.02 | 0.00 | 12.04 | **<.001** | 1.02 | 1.02, 1.03 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction. Participants are modelled as random effects.

The additive effects of main group effects and interactions show the differences in clusters’ learning patterns when compared to non-learners. Non-learners show no learning (evident by non-significant intercept and matrix number). Slow learners show significant effect for matrix number (matrix number by slow learners interaction), which is canceled at training beginning by a negative main effect for slow learners. Quick learners show significant effects for matrix number (matrix number by quick learners interaction), including at training beginning (main effect for quick learners). Effects for the slow and quick learners are contrasted against non-learners.

**Table S\_CA6.** Group comparison in a mixed-effects linear model with ***slow learners*** as the reference group (non-learners excluded from the model)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | SE | Z | p | OR | 95% CI |
| Intercept | -0.24 | 0.12 | -2.04 | .06 | 0.79 | 0.62, 0.99 |
| **Matrix number (1-120)** | 0.03 | 0.00 | 16.94 | **<.001** | 1.03 | 1.02, 1.03 |
| **Quick learners** | 1.45 | 0.16 | 9.02 | **<.001** | 4.26 | 3.11, 5.84 |
| Matrix number (1-120): Quick learners | 0.00 | 0.00 | -1.83 | .07 | 1.00 | 0.99, 1.00 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction. Participants are modelled as random effects.

**Cluster Comparisons**

**Table S\_CA7.** Learning Cluster by ***Reinforcer***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non-learners | Slow learners | Quick learners | Overall |
| Music | 27 (46.5%) | 10 (17.2%) | 21 (36.2%) | 58 (100%) |
| White noise | 28 (48.3%) | 13 (22.4%) | 17 (29.3%) | 58 (100%) |
| Overall | 55 (47.4%) | 23 (19.8%) | 38 (32.8%) | 116 (100%) |

Chi square=0.83, p=.66.

**Table S\_CA8.** Learning Cluster by ***Group* - *Music***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non-learners | Slow learners | Quick learners | Overall |
| LD | 14 (46.7%) | 4 (13.3%) | 12 (40.0%) | 30 (100%) |
| HD | 13 (46.4%) | 6 (21.4%) | 9 (32.1%) | 28 (100%) |
| Overall | 27 (46.6%) | 10 (17.2%) | 21 (36.2%) | 58 (100%) |

Chi square=0.80, p=.67.

LD=low depression symptoms; HD=high depression symptoms.

**Table S\_CA9.** Learning Cluster by ***Group*** **– *White Noise***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non-learners | Slow learners | Quick learners | Overall |
| LD | 16 (53.3%) | 6 (20.0%) | 8 (26.7%) | 30 (100%) |
| HD | 12 (42.9%) | 7 (25.0%) | 9 (32.1%) | 28 (100%) |
| Overall | 28 (48.3%) | 13 (22.4%) | 17 (29.3%) | 58 (100%) |

Chi square=0.64, p=.73.

LD=low depression symptoms; HD=high depression symptoms.

**Table S\_CA10.** LearningClusters by ***Explicit rule learning* - *Music***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non-learners | Slow learners | Quick learners | Overall |
| 0 (no learning) | 26 (96.3%) | 4 (40.0%) | 3 (14.3%) | 33 (56.9%) |
| 1 (learning) | 1 (3.7%) | 6 (60.0%) | 18 (85.7%) | 25 (43.1%) |
| Overall | 27 (100%) | 10 (100%) | 21 (100%) | 58 (100%) |

Chi square=33.8, **p<.001**

Chi square (quick/slow learners only)=1.30, p=.25

**Table S\_CA11.** Learning Clusters by ***Explicit rule learning* – *White Noise***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Non-learners | Slow learners | Quick learners | Overall |
| 0 (no learning) | 28 (100%) | 1 (7.7%) | 1 (5.9%) | 30 (51.7%) |
| 1 (learning) | 0 (0.0%) | 12 (92.3%) | 16 (94.1%) | 28 (48.3%) |
| Overall | 28 (100%) | 13 (100%) | 17 (100%) | 58 (100%) |

Chi square=50.5, **p<.001**

Chi square (quick/slow learners only)=0.00, p=1.0

**Table S\_CA12.** Learning Clusters and ***Near transfer effects – Music*** (Reference group: non-learners). Mixed effects linear regression – Dependent variable: near transfer; Random effect: group

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B (95% CI) | SE | t | p |
| Intercept | -1.39 (-5.58, 2.79) | 1.82 | -0.76 | .56 |
| **Slow learners** | 4.42 (0.93, 7.80) | 1.75 | 2.53 | **.022** |
| **Quick learners** | 4.80 (2.13, 7.51) | 1.37 | 3.49 | **.003** |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA13.** Learning Clusters and ***Near transfer effects – Music*** (Reference group: slow learners).Mixed effects linear regression – Dependent variable: near transfer; Random effect: group

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B (95% CI) | SE | t | p |
| Intercept | 3.39 (-5.24, 12.11) | 3.79 | 0.89 | .91 |
| Quick learners | -0.24 (-4.32, 4.07) | 2.10 | -0.11 | .91 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA14.** Learning Clusters and ***Near transfer effects – White Noise*** (Reference group: non-learners). Mixed effects linear regression – Dependent variable: near transfer; Random effect: group

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B (95% CI) | SE | t | p |
| Intercept | -0.38 (-1.78, 1.03) | 0.72 | -0.52 | .60 |
| **Slow learners** | 5.92 (3.43, 8.41) | 1.28 | 4.61 | **<.001** |
| **Quick learners** | 6.34 (4.05, 8.62) | 1.18 | 5.39 | **<.001** |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.

**Table S\_CA15.** Learning Clusters and ***Near transfer effects – White Niose*** (Reference group: slow learners).Mixed effects linear regression – Dependent variable: near transfer; Random effect: group

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | B (95% CI) | SE | t | p |
| Intercept | 5.54 (2.86, 8.23) | 1.38 | 4.02 | <.001 |
| Quick learners | 0.42 (-3.16, 4.00) | 1.83 | 0.23 | .82 |

Note. P-values are adjusted to the false discovery rate using Benjamini-Hochberg FDR correction.